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QRP Quarterly

Volume 51 Number 3
Summer 2010
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Journal of the QRP Amateur Radio Club International

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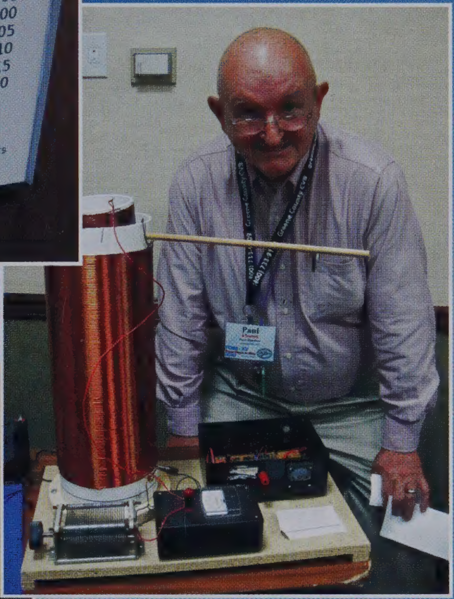
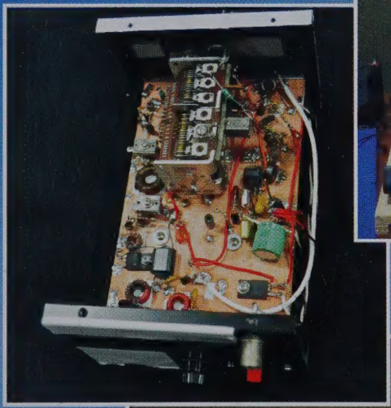


KE6TI's 72-part Transceiver



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- Two Great Projects from the FDIM 72-Part Challenge
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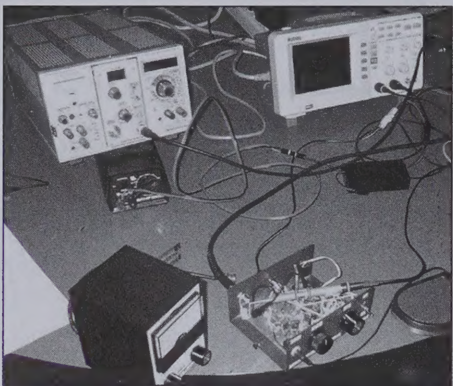

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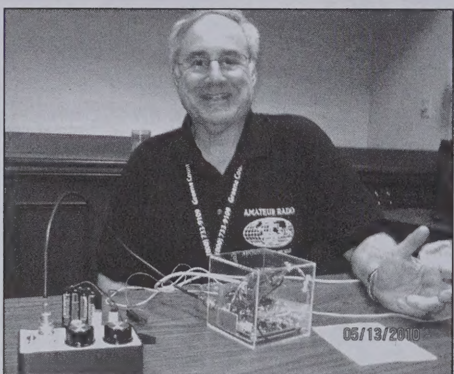

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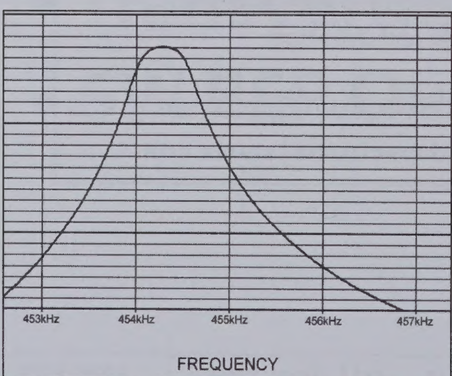

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Technical Articles

The Joy of QRP

The World of QRP ARCI

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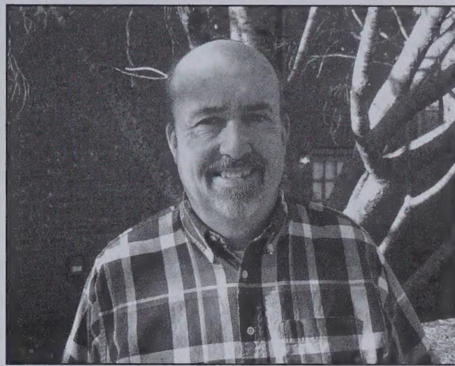


FDIM 2010—Attendance, Recognition and the Future

FDIM 2010 is now history. A great deal of effort by an all volunteer team made it come together. It was both hectic and enjoyable for me. Hectic in that there was non-stop activity and responsibility. Enjoyable as it was great to renew friendships and make new ones. Our FDIM Manager, Norm Schklar, WA4ZXV did an outstanding job of insuring everything went as planned. Numerous volunteers came together to insure all went well. Many at the event asked me about numbers as they were wondering if the economy took a toll on attendance. Surprisingly, this year was the highest attendance numbers we have had in 15 years. The two events that require registration (thus we can accurately report attendance numbers) are the Seminar and the Awards Banquet. This year we had 255 people at the Seminar and 227 at the Awards Banquet. Both of these numbers are "high water marks." The number of QRP Vendors present was similar to previous years. The ballroom on both Thursday and Friday nights were crowded. We had the usual homebrew contest along with a challenge to build a transceiver with 72 or less parts. Both of these contests had great entries and are covered elsewhere in this issue. We tried to include those that could not attend by webcasting as much of the activity as possible. We hope you enjoyed this inclusionary effort and are planning to continue to webcast when ever possible.

Special Recognition

This year was the fifteenth anniversary of FDIM. I remember the first FDIM when about 100 of us gathered at the Days Inn South Dayton (later Ramada) for the first seminar in the series. Back then it was an effort of a four brave souls—Bruce Muscolino, W6TOY/3, Bob Gobrick, NØEB, Preston Douglas, WJ2V, and Paulette Quick, N9OUH (now WB9VHF). Bruce and Bob are now silent keys (and our very great loss), but they can rest assured that their spirit lives on as the FDIM continues. We were fortunate to have the two remaining founders present for FDIM 15. At the beginning of the seminar, Preston Douglas, WJ2V and Paulette Quick, WB9VHF were given a plaque thanking them for their leadership and risk taking in start this now world renown QRP event. The FDIM format has become a standard used by other ham events. FDIM has become a benchmark for similar events. We thank our founders for their vision.

QRP Honor Roll

The QRP Honor Roll is a special recognition awarded by the president to active members that have made exceptional contributions to QRP ARCI. This year two people received this recognition. They are outgoing Director John Cumming, VE3JC and Membership Chairperson Charlotte Nelson, KJ4EDM.

John has been a member of the Board of Directors for the past four years with his term expiring on June 30, 2010. His ideas were well thought out and always presented with respect for differing opinions. We have seen our Canadian membership grow on John's tenure and he managed to bring some fellow Canadians along to FDIM each year. His input was helpful and valued when selecting volunteers for various functions and his assistance and ideas were very helpful with managing some inventory issues with the Toy Store. He will be missed.

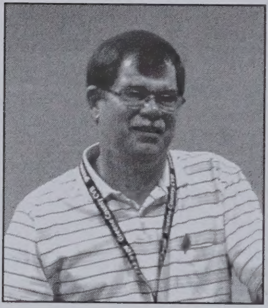
Charlotte is the one person in the club that interacts with each and every member. She maintains the membership database by processing each new member and renewing member information into access and passing the related financial data to the bank. Yes, this is still a manual process that

she does willingly!! She sends an email to each new member and renewing member explaining when their subscription will start and end as well as when their data will appear on the websites member lookup function. As the club grows, this continues to be a very time consuming task and at times becomes a full time job! She is currently working with other staff to automate this process. Here efforts keep everything running smoothly.

QRP Hall of Fame

For more than 10 years, the club has solicited and honored those who have made a significant contribution to the world of QRP. Inductees are honored at the FDIM Awards Banquet with a plaque presented to them by QRP ARCI. Nominations may be submitted by anyone, whether a member of the QRP ARCI or not. Similarly, membership in QRP ARCI is not required for someone to receive the honor, since this is an award to recognize those who have made great ongoing contributions to the QRP community, not just to the QRP ARCI. The voting body consists of the QRP ARCI Board of Directors, President, Vice-President and last eight members inducted into the Hall of Fame. Of the nominations received this year, three people received the two thirds majority of the voting body required to be inducted into the hall of Fame. They are:

- Rex Harper, W1REX
- Dave Ingram, K4TWJ (SK)
- Jim Stafford, W4QO



Rex Harper, W1REX

Rex Harper, W1REX is known to many of us and has given a lot of pleasure to numerous QRPers. His novel range of kits has enabled many beginners to build viable projects. Although he has a commercial interest in his kits, many times at hamfests he brings along items to give away to encourage QRP construction.

He has given talks at many QRP events—on a variety of subjects—all of which show his technical knowledge and his enthusiasm for the QRP world. He has run a QRP event of his own for the past few years: Lobstercon. This is held at a camping ground in Maine and he encourages everyone to bring QRP radios and operate them there.

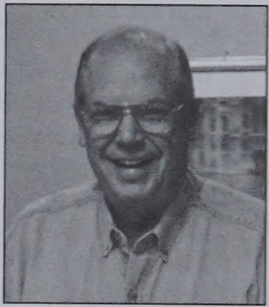
His active participation in Buildathon events, often supplying parts at low cost, and being an Elmer on the day, has helped to make the events a success and introduce many to both building and QRP. Rex was instrumental at the FDIM 2009 Buildathon and the GQRP mini Convention's Buildathon. Above all everyone that knows him commends his cheerfulness and enthusiasm. To quote from one of the people that nominated him, "He encourages QRP by loving it himself and sharing the pleasure he derives from it. It is simply good to be with Rex at any QRP event."

Dave Ingram, K4TWJ (SK)—Dave's lifetime of ham participation, and innovation speaks for itself. He was a dedicated QRP enthusiast and Dave embodied the same spirit of amateur radio that QRP ARCI has encouraged over the years. He was a skilled CW operator and constructor of simple and inexpensive radio equipment. He communicated this enthusiasm for QRP over the many years that his columns ran in *CQ* magazine and elsewhere.

Dave Ingram, K4TWJ (SK)

His many books that dealt with QRP topics and with the appreciation of that most basic of amateur radio instruments, the telegraph key helped many discover the fun that QRP and building bring to the hobby. In addition to being a cheerleader, in his columns he was also a versatile teacher with the ability to make complex technical subjects accessible to that large group of hams who are not electrical engineers.

Dave's contributions to QRP and the amateur community were many, and they will continue to be shared in the legacy of magazine columns and books that he has left to us.



Jim Stafford, W4QO

Jim Stafford, W4QO, has sparked interest in QRP for many years by speaking about QRP at numerous clubs and hamfests. Untold numbers of hams have been introduced to the "joys of QRP" through Jim's many activities. Jim, along with a few others, was a founder of NOGA QRP club in the early 1990s. He served as VP of QRP ARCI in 1998 and part of 1999. He was later elected President of QRP ARCI. During his tenure as President he worked to increase the number of QRP ARCI members and to improve *QRP Quarterly*. A great deal of his effort went to increasing awareness of QRP to the general amateur radio community.

Jim has represented QRP ARCI at numerous Hamfests including Pacificon, Celticon and Hamcom, in addition to numerous regional events and radio clubs. He served as chairman of FDIM for two years and worked successfully on the door prize team, including developing a relationship with many QRP vendors which resulted in their participation at FDIM. He contributed to the development of portions of the NOGA Pig Kit, which has sold hundreds of kits throughout the world. Over the years Jim has spoken at the Dayton Hamvention representing QRP ARCI. During his ham career he operated almost every mode in ham radio and through his leadership has contributed significantly to our hobby. He has been a "QRP Ambassador" for many years.

The Future

Plans are already underway for FDIM 2011. You can count on building contests, recognition awards and the Hall of Fame to continue to be part of FDIM. Next year, 2011 will be a milestone for the club as QRP ARCI will celebrate its 50th anniversary. So there may be some surprises and new things added to the agenda to mark the 50 years of QRP ARCI. Please feel free to pass along your thoughts for the 50th celebration. The best part of FDIM 2011 however will be the people that attend. Meeting and talking with people with similar interests and exchanging ideas are the best things that happen. Please plan on attending.

—72, Ken Evans, W4DU

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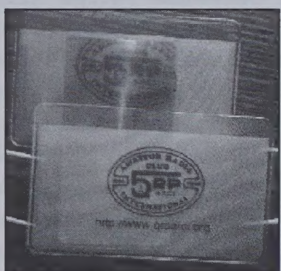

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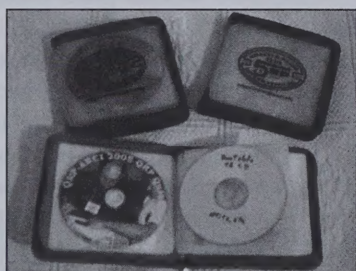

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Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

Small Transmitting Loops Test (Quickie #74)

Joe Everhart, N2CX, continues the endless string of Technical Quickies he promised me back in the early 90s with installment 74—

So-called magnetic loops or small transmitting loops (STL) are a terrific area to investigate. They promise small size and reasonable efficiency in a size that is quite attractive for those with space or resident's association restrictions. They can, however be pricey to buy and difficult to evaluate if you build your own. I've recently been evaluating use of metal flashing to make inexpensive high efficiency roll-your-own designs. See Reference 1 for the design of a simple, efficient tuning capacitor using flashing.

The device in Figure 1 is a circular STL made from aluminum flashing that George Heron (N2APB) and I designed. George runs a company that offers products for radio amateurs named Midnight Design Solutions (www.midnightdesign-solutions.com) so since he did the mechanical design he called it the Midnight Loop. It's three feet in diameter and covers the 20 meter ham band. Most of the construction is aluminum flashing and PVC pipe available at your basic hardware megastore. We described it in a presentation at Masscon, the 2010 Massachussets QRP conference, in March. You can find the slides from that presentation at the link in Ref 2.

One of the difficulties we had was evaluating just how efficient it was. Most similar loops are constructed of either large diameter wire or metal tubing and there are easy to find design equations for those materials. The *ARRL Antenna Book* has a good set of those equations as do many web sites. My favorite such site is the AA5TB site (Ref 3). The Masscon presentation slides show the results of calculations for several familiar loop designs based on the AA5TB calculator (Ref 4). The MFJ-1788 loop is a "standard" of sorts since it is well constructed and has good efficiency due to its welded plate tuning capacitor.

Unfortunately I've been unable to locate exact design equations for loops constructed of wide metal strip material as used in the Midnight Loop. The loop inductance and tuning capacitance can be estimated and optimized experimentally but not the loss and radiation resistance needed to determine its efficiency. Once we built the loop it was a simple matter to measure the resonant frequency and to estimate the loop inductance and required tuning capacitance. However we had no way to determine the radiation and loss resistances to tell how efficient it was.

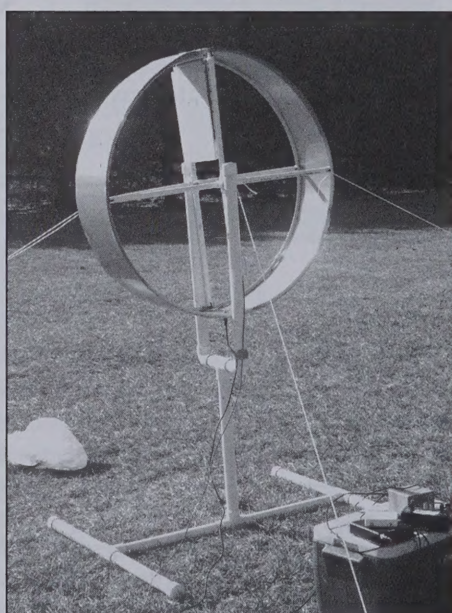


Figure 1—The Midnight Loop, made from aluminum flashing.

One other parameter we were able to measure was the SWR bandwidth. Now for a resonant circuit, in this case the tuned loop, the 3 dB bandwidth is the high and low frequencies around resonance where the SWR reaches 2.62:1. With the Midnight Loop it was almost twice the bandwidth of the MFJ loop on 20 meters. On the face of it this was discouraging since, all other things being equal, double the bandwidth indicated double the loss or half the efficiency!

As you can see in the Masscon slides we effectively used the Midnight Design Solutions AA908 antenna Analyzer for the bandwidth sweeps. Yes, I do have some slight bias in recommending this device, being its co-designer!

Lacking the ability to predict the efficiency, we decided to do a comparison test between the MFJ loop and the Midnight Loop. Ideally this would be done on an antenna range under very controlled conditions using very $$$ test equipment. A less rigorous method would be to use a good network analyzer such as Rudy Severns N6LF did in his evaluations of vertical antenna ground radial systems. His testing was described in *QEX* and the articles are available on his web site (Ref. 5).

However, we decided that this level of effort was overkill for a simple comparison test. It seemed logical that a mini-test range could be achieved by simply setting up the loop antennas one at a time and transmitting a low power signal through them while noting the received signal strength in a nearby test receiver. If the surroundings were carefully controlled, we reasoned, and test conditions were kept constant, the comparisons would be valid.

A practical test area could be a relatively flat field with room to set up the loop under test 100 feet from a receive antenna.

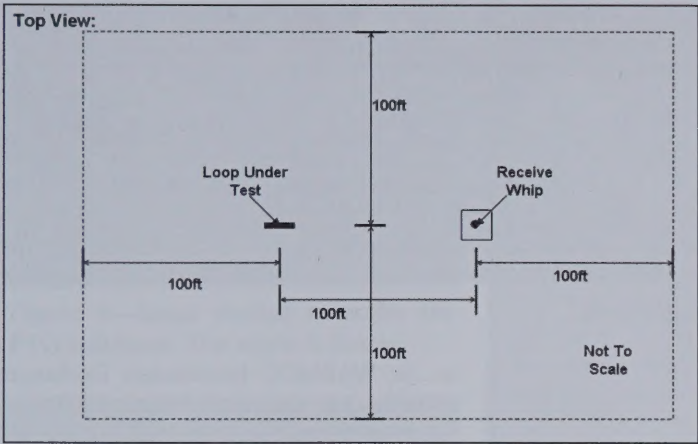


Figure 2—Antenna test configuration.

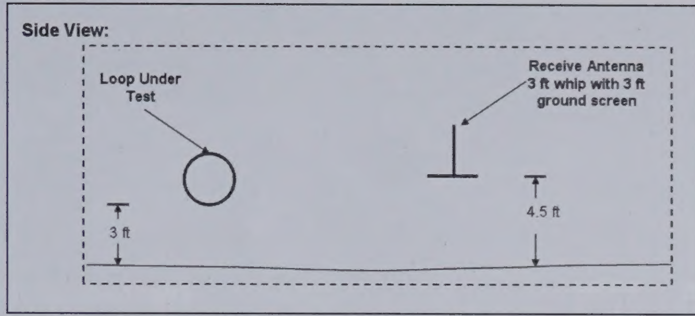


Figure 3—Side view of antenna test set-up.

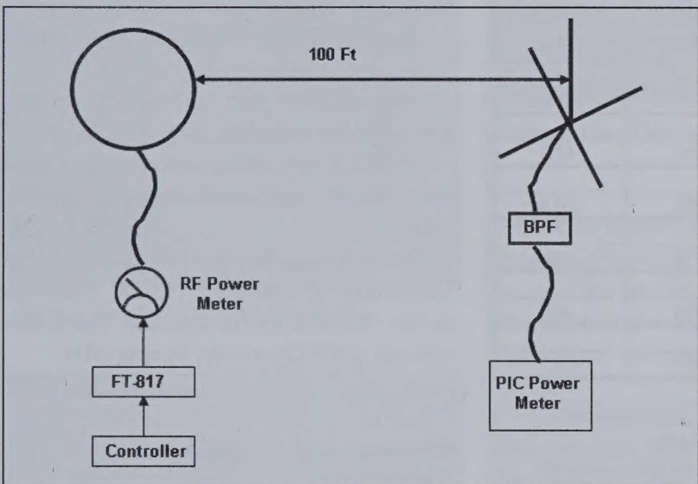


Figure 4—Electrical configuration of antenna test.

Figure 5—N2CX with the MFJ loop at the original test site.

We wanted an area with no large metallic structures within 100 feet on all sides and no nearby sources of electrical noise or RF interference. Since the loops radiation is vertically polarized the receive antenna could be a ground plane antenna with its base at the height of the loop under test. Figures 2 and 3 are the configurations we wanted.

For test equipment it was felt that simplest is best so we ended up with the setup shown in Figure 4. The test controller is a simple PICAXE 08M chip that supplies a keying signal to an FT-817 (set to about 0.5 W CW) with a controlled pattern. It keys the rig on for several seconds to send the signal to be received, then off for several seconds to monitor for any in-band signals or noise, then it sends the callsign N2CX in Morse code for identification. It was described in a recent Joe's Quickie (Ref. 6). A NorCal RF Power/SWR meter was used to monitor the loop SWR and transmitter output power.

On the receive side, a 3-foot whip antenna with a ground plane was made from PVC pipe parts. A band pass filter was made using a T50-6 toroid core with about 25 turns of 26 gauge wire and a 100 pF tuning capacitor. This was connected from the whip to the ground plane and coupled to the coax feedline with a 3-turn link. It served to reject any off-frequency RF. Received RF signal strength was measured using a KA7EXM PIC Power meter. This handy device measures and displays RF power levels in the range of –80 to +7 dBm. The aforementioned bandpass filter was required to prevent stray RF from being measured.

The prime test area was a farm field in a rural area near the N2APB QTH that met all of the desired criteria. Figure 5 shows the MFJ loop set up for measurement at the farm site. Unfortunately on the day of the test conditions were less than ideal. When setup first began the temperature was in the 50s with sunshine and a light breeze (and some snow on the ground). Within an hour or so the sky clouded over, the temperature plummeted and mixed precipitation began to fall. We decided to abandon testing and break down for more benign weather.

The next week we decided that N2APB's back yard was close enough to our desired environment. We decided that it was (no pun intended) close enough even though there were some trees within 50 feet off to the side and one end of the area. At 20 meters they should present little corruption of transmitted and received signals. Figure 6 is a photo of both ends of the test setup with N2CX eyeballing the relative positions of the test loop and the receive antenna.

This time all went pretty well. We felt that each loop would be set up individually with as close to the same power as possible and the received signal would be monitored. First the loop would be oriented with its axis parallel to a line between

Figure 6—N2CX and the complete antenna test set-up in the N2APB yard.

Comparative Loop Antenna Tests						
						Mar 8, 2010
Forest Hill, MD						
Weather: clear, about 50-degF sunny with a light wind						
Time	**Freq (MHz)**	**SWR**	**Xmit Pwr (Watts)**	**Battery (Volts)**	**Rx Noise (dBm)**	**Rx Signal (dBm)**
Test 1: MFJ Loop oriented toward receive antenna						
2:44 PM	14.080	1.9	0.4	12.4	-67	-24.6
Test 2: MFJ Loop rotated 90 deg. CW						
2:57 PM	14.096	1.9	0.4		-64	-42.1
Test 3: MFJ Loop rotated 180 deg. CW						
3:02 PM	14.096	1.9	0.4		-64	-24.6
Test 4: Midnight Loop oriented toward receive antenna						
3:25 PM	14.02	1.5	.3/.4		-59	-24
Test 5: Midnight Loop rotated 90 deg. CW						
3:38 AM	14.046	1.5	.3/.4	12V	-60	-43
Test 6: Midnight Loop rotated 180 deg. CW						
3:45 PM	14.1	1.8	0.4	11.5V	-68	-23.1

Notes:
1. Approx 40 db S/N ratio at receive end means test data not contaminated by noise
2. 17 dB null with MFJ loop 90 deg. transmission path indicates little or no loop feedline radiation.
3. Identical received signals when MFJ loop turned 180 deg. Shows good pattern symmetry.
4. Stronger received signal from Midnight Loop suggests higher efficiency than the MFJ loop, on the order of 1 dB.
5. Midnight Loop also shows deep null when broadside, suggesting low feedline radiation.
6. Transmit power cannot be accurately accounted for since measurement resolution was 0.1 W. Apparent lower transmit power might yield even higher efficiency for Midnight Loop.

Figure 7—Test results.

the transmit and received ends of the path and the signal would be monitored. This would result in maximum signal toward the receiver. Then the loop would be rotated 90 degrees clockwise to orient the pattern null toward the receiver. This would show the depth of the null and verify that the feedlines were not contributing any radiation.

Finally, the loop would be rotated an additional 90 degrees to confirm that the pattern was the desired, symmetrical figure-8. The same regime was followed for both loops, each placed individually at the test loop location. As a side note it was found that the loops had to be tied in place to hold them secure while testing since, with our impromptu mounting scheme, even a light wind moved them around. We had concerns that the rotation and tie-down might detune the loops and this proved to be the case.

Figure 7 shows the test results. Indeed, both loops showed a significant null and a nearly identical radiation pattern for both main lobes. Quite surprisingly the Midnight Loop showed a higher received signal strength of 0.6 to 1 dB indicating better radiation efficiency than the MFJ loop! In our opinion this confirms the value of using a large flat conductor for an STL. Its relatively modest mechanical ruggedness, however, probably means that it is best suited for attic antenna usage.

References:

1. Joe's Quickie No. 68, "Magnetic Loop Tuning Capacitor," N2CX, included in the WA8MCQ Information Exchange column, *QRP Quarterly*, Winter 2009.

2. Midnight loop slides from Masscon: http://www.midnightdesignsolutions.com/MidnightLoop/index.html

3. AA5TB loop antenna site: http://www.aa5tb.com/loop.html

4. AA5TB loop calculator: http://www.aa5tb.com/aa5tb_loop_v1.22a.xls

5. N6LF site with ground radial evaluation tests: http://www.antennasbyn6lf.com/

6. Joe's Quickie No. 73, "Quickie Test Transmitter Controller," N2CX, included in the WA8MCQ Information Exchange column, *QRP Quarterly*, Spring 2010.

—DE N2CX

Mounting BNC Connectors in Altoids Tins

From Vojtìch Bubník, AB2ZA, posted to qrp-l@qth.net—

Many electrons were exchanged on the topic of how to drill holes in the Altoids tin already. Let me suggest another solution, which I believe I did not hear before: Epoxy a piece of copper clad board inside the tin where you will drill. Sand both the copper clad board and tin before epoxy is applied.

This trick works very well if you want to mount a BNC connector on the side of the tin. It does not hold well in the thin metal and it will hardly hold when the bayonet gets twisted. A piece of copper clad board reinforces the tin nicely.

—DE AB2ZA

Mounting Method for a PTO Coil

From Chris Waldrup, KD4PBJ (condensed from a series of e-mails)—

I was needing a permeability tuned oscillator (PTO) for an upcoming project, and after some thought came up with the following method of coil support. It is easy and cheap. On a trip to a McDonalds fast food restaurant with my son a month or so

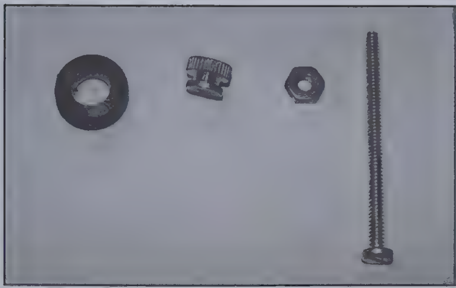


Figure 8—Items needed to make the PTO coil form. The screw is brass.

Figure 11—The completed coil.

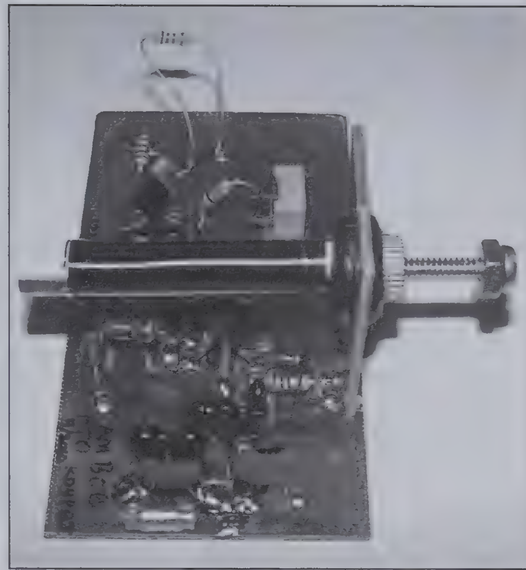


Figure 12—The grommet fits in a hole drilled in a piece of PCB material used as a bracket.

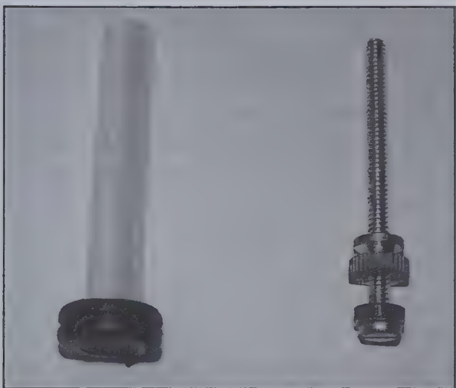


Figure 9—Assembling the form.

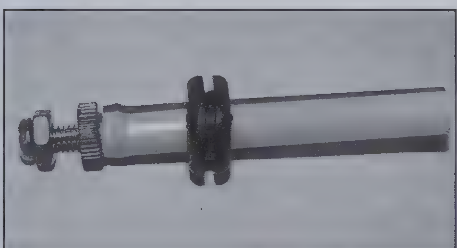


Figure 10—Completed PTO coil form.

ago for some sweet tea on the way home from school, I realized the straws were larger than at other restaurants. So the idea was born.

I wound the coil on a length of plastic straw. Figures 8, 9 and 10 show assembly of the form, Figure 11 shows the finished coil (with 111 turns), and Figure 12 shows it installed in an oscillator. A knurled brass thumb nut fits into the straw to hold the brass screw, and a rubber grommet that fits snugly over the assembly allows attachment to a bracket made of copper clad PCB that is soldered to the main board. I put a little bit of cyanoacrylate glue over the shoulder of the thumbnut to hold it in place in the straw.

The circuit, shown in Figure 13, is not ham radio per se. It is a 40 meter PTO modified and scaled down to the 1500-1600 kHz region, the high end of the AM broadcast band, for a Part 15 AM transmitter on Charles Wenzel's Techlib website. He said to use a crystal for the AM band. I didn't have one so I improvised. It is QRP, though.

[The web site is at http://www.techlib.com, then look under Circuits. There are quite a few interesting things there. —WA8MCQ]

I had to place a lot of capacitance in the tuned circuit. I had wound the coil to the "looks good to me" specification and adjusted for resonance with the caps. (I looked at the coil under my stereo microscope and there are roughly 111 turns, not 104 turns as originally believed.) I used both polystyrene and silver mica caps in hopes to cancel the drift, and also ended up using some NP0 ceramic disks.

The oscillator design was inspired by the AmQRP Tin Ear receiver and a NorCal QRP transceiver but had to be modified to work that low in frequency. Fellow Knightlites John Marshall KU4AF and Rye Gewalt K9LCJ suggested a source follower as a buffer. I had problems with clipping on negative peaks on the output of the follower and after trying many fixes unsuccessfully Rye offered a suggestion.

He had me unground the 1 Meg gate resistor, and tie it to the wiper of a 10 K trimmer. One side of the trimmer was at 12 volts, the other side grounded. I then adjusted the pot for a clean sine wave as seen on my scope, measured across a 2k ohm load resistor temporarily connected to the output (the circuit this will be driving has a 2k input impedance).

—DE KD4PBJ

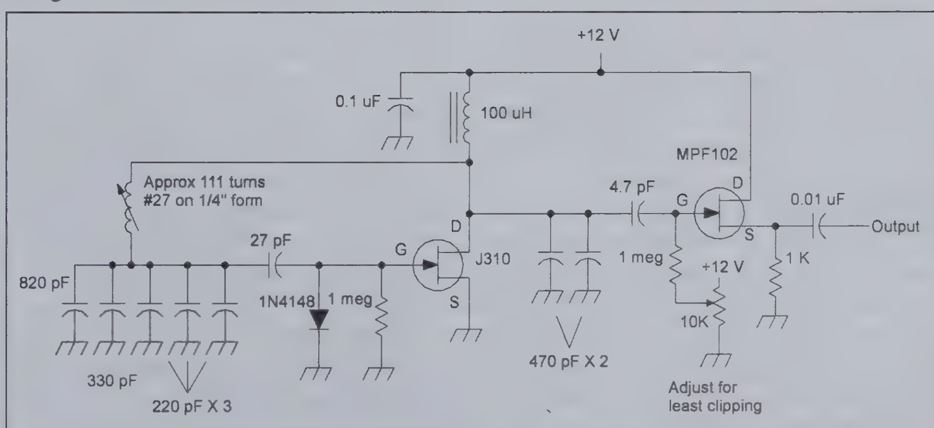


Figure 13—Schematic of the PTO. This one is for the high end of the AM broadcast band.

Signal Generator vs. Test Oscillator vs. Synthesizer

Eham.net is an excellent general purpose ham web site and among other things they have a number of forums. One of those is Homebrew, where a wide variety of topics are discussed. Here's an interesting one from April of last year—

This question was tossed out by NR9R—

I need a stable, clean signal source for receiver measurements. I don't need a modulated signal so the typical RF signal generator with AM and FM modes is overkill. I also don't need a variable RF output since I have inline attenuators.

It appears that what HP calls a test oscillator is an unmodulated signal source with variable output. Also, what HP calls a Frequency Synthesizer is a calibrated constant output that can be varied in frequency to provide a reference.

Is there any reason I can't just use a frequency synthesizer or test oscillator as my signal source for intermodulation distortion measurement? These devices can be found for a fraction of the price of a reliable signal generator.

Steve Katz, WB2WIK/6 provided this reply—

If you want to make receiver measurements at the RF stage level (not IF or audio), there's a huge difference. A real signal generator has incredible shielding to prevent the generated signal from radiating out the enclosure, past attenuators and connectors, etc. A real signal generator can generally be "dialed" down to sub-microvolt level amplitude, and you can believe the indication because the generator's well shielded enough to actually do that.

An "oscillator" that is not a laboratory grade signal generator is usually poorly shielded and might put out 10 Vrms or so, adjustable down to lots of millivolts, perhaps. You can add 100 dB of external attenuation to that, but the signal won't be reduced 100 dB in a receiver, because the oscillator itself will radiate far more signal that is passed by the attenuator(s).

What makes real signal generators expensive is typically:

- Leveled output (ALC) across the entire frequency spread, so any output level indication remains correct at any frequency.
- Tremendous shielding (usually greater than 140 dB worth, across the entire frequency range) so the generator cannot radiate any signal that can be detected by a nearby receiver, at all. The only place the signal comes out is via the RF output connector.
- Very low distortion, both harmonic and non-harmonic, so the frequency you read is the frequency you get. The 2x, 3x, 4x etc harmonics are often 40-60 dB down or more. Non-harmonic spurious things are usually down farther than that.
- Very low modulation distortion for whatever modes the generator handles.
- The ability to "dial up" to about 1 Vrms or so and down to < 0.1 uVrms, on any frequency, with ±1 dB level accuracy.
- Usually, an accurate indication of the operating frequency.

"It appears that what HP calls a test oscillator is an unmodulated signal source with variable output."

That's likely true. But the variable output cannot be turned down very far, because the instrument has inadequate shielding to allow that. Also, the output is likely not leveled, so you need an outboard instrument to measure what the level actually is. Further, the harmonic distortion may not be great.

"Also, what HP calls a Frequency Synthesizer is a calibrated-constant output that can be varied in frequency to provide a reference."

Most modern signal generators are frequency synthesized, so this term alone doesn't mean much. Some frequency synthesizers are intended to be part of a larger system, and can be accurately set to a frequency but nothing else is adjustable, including amplitude. And those types of instruments usually are not sufficiently shielded to be used as a signal generator, at least not near receivers.

"Is there any reason I can't just use a frequency synthesizer or test oscillator as my signal source for intermodulation distortion measurement? These devices can be found for a fraction of the price of a reliable signal generator."

If you're working with receivers, you generally need a real RF signal generator with low distortion and excellent shielding. You can pick up a used HP 8640B (c. 1975) for less than $250, usually. That covers about 1-512 MHz, is adjustable down to –140 dBm, has output leveling, low distortion, etc. It was a $3000 instrument when new, and are now "cheap" only because they're old. A lot of these 30 year-old instruments still work fine; I'd get a hands-on demo to be sure before buying one. They're easy to find.

—DE WB2WIK/6

Steve later added these comments—

Another good oldie but goodie is the Boonton 102A-B-C family, similar to the 8640B in most ways.

I worked on the 8640 program when I was with HP, and also worked on the 102 program when I was with Boonton (early-mid 1970s). My 8640B is from 1974 and still works perfectly, but then I know how to service it very well, and it's never been abused.

If you're looking for a very "clean" RF source, even an old HP 608 (C, D, E or F) would suffice. It's not phase locked and can drift a bit from a cold start, but after 30 minutes or so should be within a couple of hundred Hz. It's actually a cleaner signal source than the 8640B is, and cleaner than many modern generators costing thousands of dollars. Reason is, it's not synthesized, it's not phase-locked; it's just a cavity oscillator running at quite a high power level, and greatly attenuated by a waveguide-below-cutoff piston attenuator which has a minimum 20 dB attenuation when set at "zero," so whatever noise the unit generates is greatly attenuated by design. And the oscillator is very clean to begin with: It's single sideband phase noise component is lower than many $20,000 generators today.

—DE WB2WIK/6

[WA8MCQ comments: Steve is the one who got me back into QRP when I returned to ham radio after a 15 year absence. Within a week or two of getting back on the air I worked him on 40M and he was running QRP, a watt or two, and then proceeded to crank it down further and further during the QSO. I was hooked again.]

Holding Round Things While Glue Sets Up

Here's a nifty idea that I saw a while back on the web page of Markus Hansen, VE7CA. Some of you may remember me

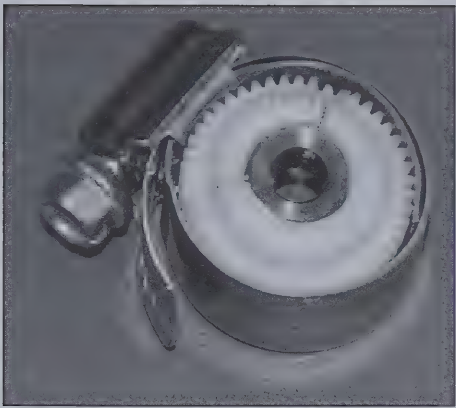


Figure 14—When gluing something round, such as a plastic gear or knob, a hose clamp can hold it together while the glue sets up. (Be careful not to crush it, or to get glue between the clamp and item.)

mentioning his site in the past; he has a section on repairs of the popular HP 8640B signal generator, which is one of my favorite pieces of test equipment at home. If you haven't visited his web site in a while, you might want to take note of the new URL: http://www.ve7ca.net

A common problem with the 8640B is cracked gears. The plastic shrinks over time but the metal core does not, and sometimes they split. The usual fix is to pop out the core, file down the hole to enlarge it a bit, then glue it all back together with epoxy. The problem is how to hold the gear together while the epoxy sets up, and his solution is shown in Figure 14—he uses a hose clamp.

As just about everyone knows, these are widely available in any place that sells automotive parts and in various sizes, and there's a good chance that any serious homebrewer will already have some kicking around the house somewhere. Myself, when I have to glue something round I'd usually use tape, twine, wire, etc, but hose clamps are a great alternative. This idea applies to gluing anything round, of course, and will come in very handy when I repair the broken knob on one of my frequency counters.

Markus does warn against tightening the clamp too much, since you may crush or damage whatever is being glued. He also reminds us to be sure there is no glue between the clamp and the round item. (You don't want the clamp to become a permanent part of it.)

Don't Heat Up Irreplaceable Plastic Items!

While we're on the subject of gluing gears, knobs, etc. back together with epoxy, here's a word of warning from the VE7CA web site, contributed by Jeff King, ZL4AI. He was gluing the plastic gears from his HP 8640B generator back together and wanted to speed up the epoxy cure. He popped it into a microwave oven for one minute, with disastrous results; the plastic melted. He didn't indicate whether it turned into a puddle of liquid plastic or just deformed it, but the results were not good. Unfortunately these are not common, off the shelf items; they are essentially irreplaceable.

I don't know how common the knowledge is that cure of epoxies can be sped up with elevated temperatures, but anyone who uses industrial epoxies at work is probably quite familiar with it. We do it all the time and have ovens all over the place for it. But we know the materials we are using and what they can handle, and we know the time vs. temperature curing schedules the adhesive manufacturers specify. More importantly, if we mess up something by getting it too hot we can just toss it out and grab another out of the big pile of parts and be a bit more careful with the next one. That's not always an option with an old piece of test equipment or an old radio.

If you have an irreplaceable, one of a kind item and are repairing it with epoxy, it's usually best to not experiment and try to speed things up with heat, whether in a microwave, conventional oven or with a heat lamp. Just let the adhesive cure at room temperature for whatever time the manufacturer specifies. It's not worth the risk.

No More New Oval HP Power Cords

Many of you will recognize the power connector and cord shown in Figures 15 and 16, which were used on a lot of old HP and other test equipment. Although many had difficulty finding the cords, I wrote in the Spring 2006 issue that they were still available at the time, off the shelf. Originally from Belden, they were being made by Volex and were available through Allied, Mouser and other distributors. Unfortunately it looks like the company has pulled the plug on this item (no pun intended).

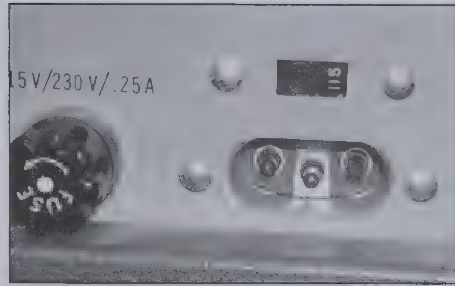


Figure 15—Power connector used long ago on test equipment and other things.

Figure 16—Mating end of the power cord for the old connector.

The subject came up on a couple of different non-QRP online discussion groups recently so I sent e-mail to Volex in early April 2010 asking about their model 17952, which is the oval cord with "reversed" hot and neutral polarity that the HP and other equipment uses. Here is the reply from Mary Foreman, Sales Manager:

"The Volex 17952 will be discontinued once the available inventory has been depleted. Volex currently has 396 pieces in stock and the distributors listed below also have stock. We are working on a possible solution which is a low profile inlet and mating female connector. Please confirm the end use application and the amperage requirement."

I don't hold too much hope for that "possible solution," which I doubt would be a suitable replacement. It sounds like a total redesign, one that would not be compatible with the old connectors.

One possible reason for dropping the item is the polarity issue, which presents certain safety and liability problems. As I pointed out in 2006, there were two different versions of the connector available, with hot and neutral reversed. (The ground was always in the same position, the cen-

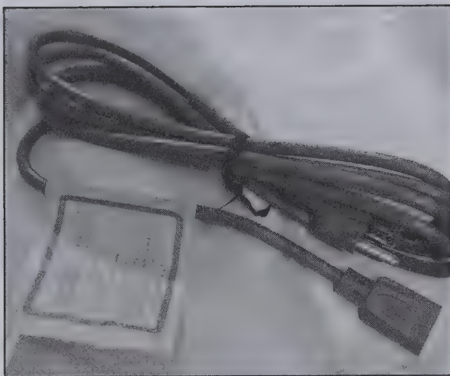


Figure 17—The nonstandard polarity version of the cord was being made with a prominent warning label. Older ones do not have it.

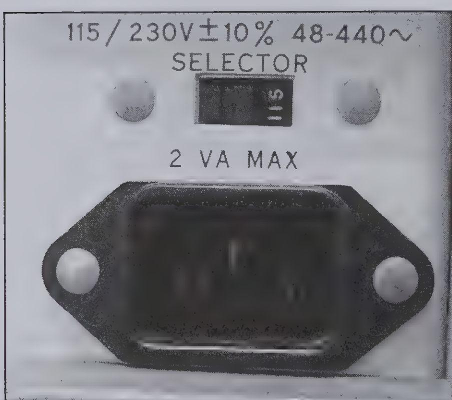


Figure 18—Currently popular power connector; mating cables are everywhere.

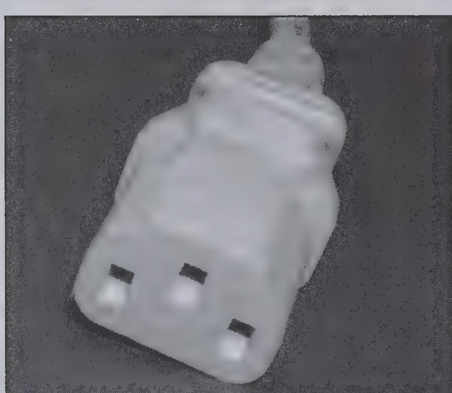


Figure 19—Mating end of the cord; everyone probably has several of these kicking around the house.

ter.) The older polarity used by HP and others years ago was backward from the current standards. The 17952 was advertised as being for replacement use only, and not for new designs; that's what the other was marketed as. The one that worked with the older equipment was being shipped with a large (several square inches), permanently attached warning label (Figure 17). Both polarities were available, with potential for confusion and worse.

As for stock at distributors, it wasn't much. Allied had 33 of them at the time, Master Distributors had 31 and Broadline Electronics Dist. had one. (I have never heard of the latter two.) Keep in mind that all of the numbers were as of early April this year and they can only be lower now. (At time of writing in June, Allied was down to 6 in stock and Mouser, where I got mine years ago, was already out in April.) The cords will no longer be easy to get, and we'll have to go back to scrounging at hamfests, etc, or paying high prices to online sources that stocked up.

Replacement of the connectors is a viable option, and not very difficult. Some on the online forums indicated that they had already replaced the older sockets with more modern ones. Everyone knows the connector shown in Figure 18, which is widely available and in use on literally hundreds of millions of pieces of equipment around the world and the matching cords (Figure 19) are easy to get. In fact, most people probably have some kicking around the house. Those who have done the replacement say that it's fairly simple and only requires a bit of metal work to get the more modern connectors to fit. You do have to watch out for the hot/neutral polarity, though, and swap around internal wires as appropriate. (You can scrounge the chassis connector from an old computer power supply or buy them from major electronics suppliers.)

—DE WA8MCQ

Cabinets and Enclosures from Dead Radios

Originally titled "Dead radios make great cabinets and enclosures," this was posted to the QRP-TECH forum on yahoo.com by Bill Martin, N7EU—

Here is a great idea for your next QRP project. Inspired by KK7B, Rick Campbell, I cruised eBay for some dead radios to use for my next radio project. I found a dead Heath Twoer *[an old 2 meter AM transceiver from decades ago — WA8MCQ]*. I gutted it and cleaned the chassis and cabinet. I then painted some primer on it. I included some pictures in the Photos section *[of the QRP-TECH home page on yahoo.com]*, with two shown in Figures 22 and 23.

Figure 22—Gutted and repainted chassis from an old radio makes a great QRP cabinet.

Figure 23—The rear deck of the Heathkit Twoer case has plenty of space for connectors, etc.

So far I have added some controls and an S meter. I plan to use this box for another QRP project. The Twoer and Sixer *[6M version]* are just the correct size for my QRP rigs. Coupled with a simple chassis and front firing speaker it is a hit with me.

—DE N7EU

The "Random" Rhombic

Subtitled "The Po' Boy Beam," this is from Larry Mergen, KØLWV—

Ever since I was a novice in 1957 I've wanted the rhombic antenna. After I retired I moved from my city lot to a one acre antenna farm in the suburbs. The acre has some trees but I also have neighbors on all sides, so I need a "stealth" rhombic. The wire used is standard black insulated wire and black zip cord, split; double zip cord is too heavy on long runs.

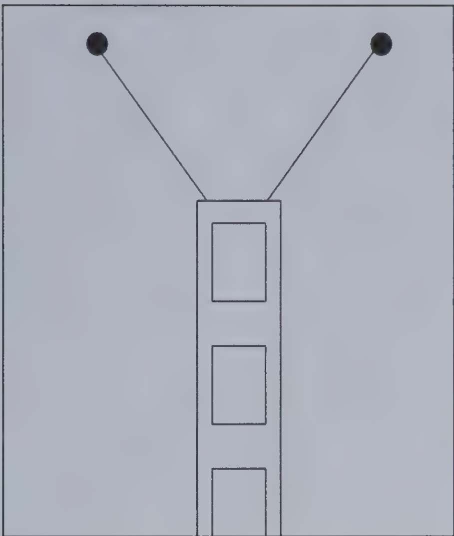


Figure 20—Fanning the end of the ladder line is said to raise the impedance.

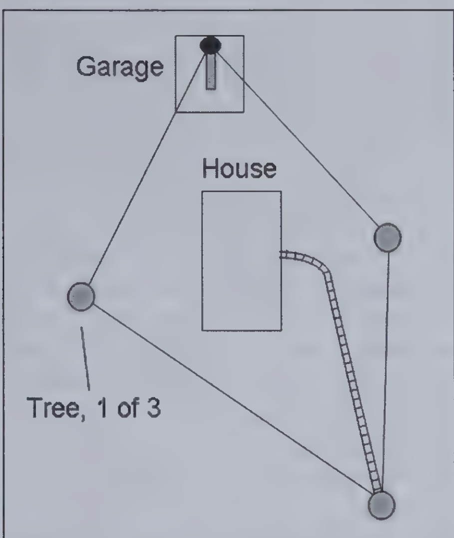


Figure 21—The Random Rhombic.

I am feeding the antenna with ladder line, 450 ohms, but the impedance of a single wire rhombic is 800 ohms. Researching on the Internet I learned about fanning the ladder line, sort of delta matching to raise the impedance. (See Figure 20.)

The rhombic, terminated, calls for a noninductive power resistor of 800 ohms. Wow! The Internet to the rescue again. www.buxcomm.com has the exact resistor. *[Don't look under "Resistors"; it's under "Antennas, T2FD and accessories" and comes as an assembled unit. —MCQ]*

Now to erect the antenna using available trees and structures. Figure 21 shows what I came up with. Angles and lengths are not exact. Some sections are 100 feet, others are 85 and 90, but it still works.

I use 3 trees and a pole on the top of the garage. Measurements are short on the termination end and the wire drops down to the top of the garage.

Perfect? No way, but very good gain, directivity and rejection from the rear. It beams to Florida so it's not the best all around antenna for all directions. To fill in other directions I use my extended double zepp, 88 foot dipole.

My rhombic tunes well from 10 through 160 meters. It's a great SWL antenna on medium waves as well.

PS—One does not need a "special" slingshot to erect wire antennas. A regular slingshot, a spool of leader on the ground and lead sinkers work just fine.

Larry later supplied this update—

It's not so random now. I made all side equal, 83 feet, and all angles are correct: 60 degrees at the feed point and terminal point. Sides equal 135 degrees. It is still sort of random because the equal sides of 83 feet aren't in any ham band. It's close to some WARC bands but I want to use the antenna for all band work so it shouldn't be a big deal. I took away the fanned input to match there, I kind of figure each time I change bands the input impedance will change anyway.

—DE KØLWV

[You can find one more Idea Exchange item on page 55 — it didn't quite fit in the regular column! —Ed.]

The Fine Print

Figure 24 illustrates what I say every issue; don't worry if you prefer not to or can't draw up schematics on the computer. Just send me one drawn by hand, and I do it up in AutoSketch. (Yes, there are some tiny differences between these two; he later sent some corrections.) The same thing goes for text; it can be via e-mail, floppy, CD or hand written. Don't worry about how you get something to me, just get it to Severn and my highly trained staff handles it all.

—DE WA8MCQ

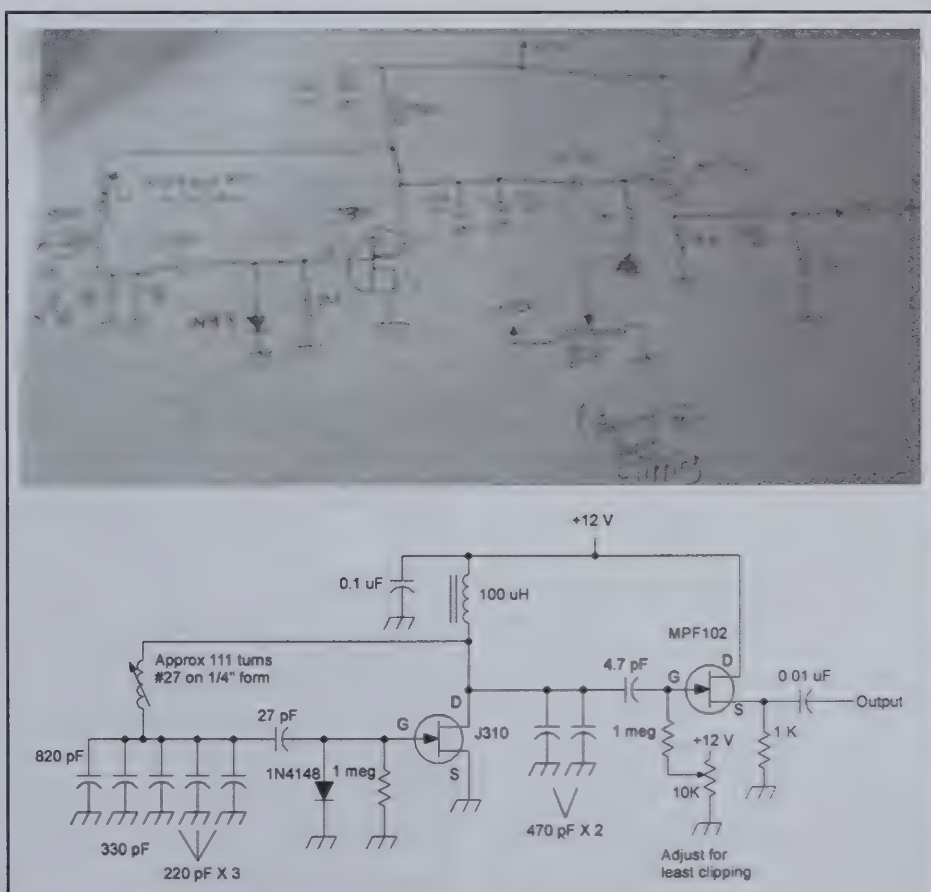


Figure 24—You send me the top half and I convert it into the bottom half.

My Recollections of Four Days in May 2010

Jeff Hetherington—VA3JFF/VE3CW contest@qrparci.org

The registration desk was busy Wednesday evening andThursday morning!

Each year hams from around the world make a pilgrimage to the Dayton Hamvention. For the past 15 years, the QRPers in the group have also gathered in Dayton during the Hamvention weekend for a meet and greet with other QRP enthusiasts. This premier QRP gathering gives the opportunity to talk to the originators of theory, products and literature, the chance to show off your QRP creations, brag about your QRP accomplishments and learn from the experiences and knowledge of our peers. FDIM 2010 was the 15th Anniversary, and one of the best on record yet.

Wednesday is typically the travel day for many of the attendees, with the registration tables opening in the evening to allow everybody to check-in and meet-up with old friends, renew acquaintances and welcome new faces. While an informal night, there is always lots of discussion about the newest gadgets, new creations and recent accomplishments. Wednesday evening also starts the buzz for Thursday's seminars as the *Proceedings* are handed out at registration and the topics of the following day's seminars and speeches are seen.

Thursday is the day when all the preparations by the volunteers and speakers is really seen. It is an early gathering in the ballroom for a day full of seminars, and you need to arrive early in order to get a good seat. It certainly looked like a record turnout for 2010 as the room was completely full.

After a brief introduction and welcome from QRP-ARCI President Ken Evans, W4DU, Anthony Luscre, K8ZT, began the informative day of seminars with a talk on QRP Contesting. Anthony covered contesting by looking at everything from Why to Contest to How to Set Goals for Success. Anthony mixed his own personal and often humourous anecdotes in with the information that he was presenting to keeping a light atmosphere that was appreciated by both the contesters and non-contesters alike.

The first technical topic of the day was The Art of QRSS presented by Hans Summers, GØUPL. Hans spoke about very slow sending and the improvements in signal-to-noise ratio that can be accomplished. He also spoke about the 30m QRSS beacon project that is being used around the world for HF propagation study and had kits available later in the evening that proved to be very popular, creating great line-ups and selling out completely before the end of the evening.

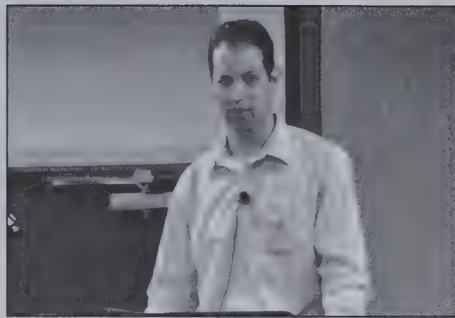
The third presentation was from FDIM seminar regular George Dobbs, G3RJV, who spoke about homemade receivers. George presented several of the receivers that he has designed, built and used over the years and described both the technical and operational merits of each. Throughout the presentation, George used his unique mix of technical knowledge, personal observation and experience to explain his topics such that everyone can understand and enjoy. George also announced a new kit from G-QRP clubs, the Limerick Style Sudden Receiver.

Scott Andersen, NE1RD, began the afternoon seminar session with a presentation titled The 100 Pound DXpedition that dealt with the idea of travelling light to be exotic DX and experience the other side of the pile-ups. Scott focused on planning for the trip, what equipment to take and how to pick an ideal location for your DXpedition. While Scott did explain that he had a very understanding YL that allowed him to bring his equipment along on a family vacation, he also described how the chance to be DX is within the grasp of many QRPers.

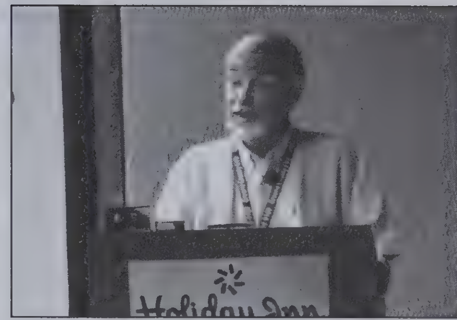
During the 2009 FDIM, Ed Hare, W1RFI, spoke about the ARRL lab performance tests. Jim Everyly, K8IKE, and Jay Slough, K4ZLE, took that as a basis for their presentation on Gud Enuff Performance Testing for the QRPer. They looked at an approach, that utilized equipment that many of us may already have on the test bench, and new ways to look at

Hundreds of QRPers filled the ballroom for Saturday evening's awards banquet.

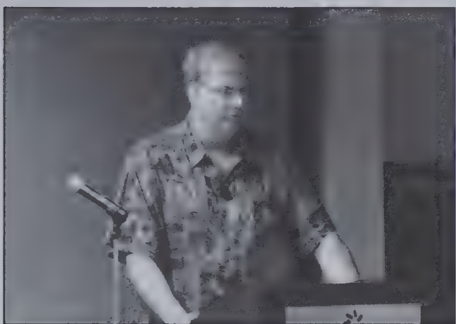
Anthony, K8ZT explained how contests can make better QRP operators.



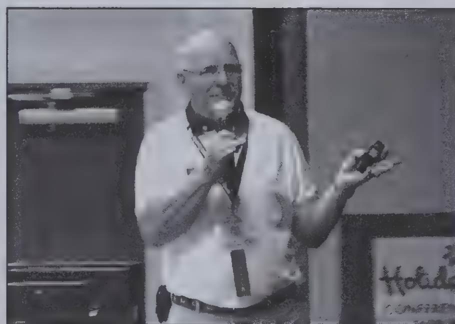
Hans, GØUPL kept the audience interested with his QRSS experiences.



George, G3RJV's talk on receivers was spiced with personal anecdotes.



Scott, NE1RD presented minimum-size (100 lb.) DXpedition ideas.



Jay, K4ZLE and his co-presenter Jim K8IKE, discussed practical test gear.

Gary, K9AY shared his experiences and insights on 80m and 160m QRP.

equipment that didn't necessarily utilize the primary function that the test equipment was designed for. They compared the equipment that would be needed to complete the ARRL Test Procedures with what might be more freely available to the QRP, and presented their list of must have equipment for an effective and good enough QRP test bench.

The last seminar of the day was presented by Gary Breed, K9AY, on Antennas and Operating QRP on the Low Bands. Gary presented many ideas and shared his personal experiences with regards to transmitting antennas and receive antennas as well as QRP techniques for success in operating the low bands. He also took the time to explain what QRP can do on the low bands. While Gary acknowledged the challenges of working low band QRP, especially for operators with limited real estate, he also explained that the rewards are worth the effort.

Thursday evening the seminar presenters all make themselves available back in the ballroom for a meet-and-greet session. All of the presenters are willing to talk about their experiences with their topics, get into more detail than they are able to with a short seminar presentation and discuss ideas and theories with the attendees. Thursday evening is also the first time that the homebrew contest entries are displayed for all to see and discuss their construction with the builders. While the vendor night is officially on Friday evening, several of the QRP vendors also set up tables in the ballroom to sell some products and every table had line-ups of QRPers waiting to buy the latest developments. Thursday evening also featured what proved to be one of the most anticipated events, with a presentation by FlexRadio. The presentation in the Theatre by Gerald Youngblood, K5SDR, and Graham Haddock, KE9H, was standing room only and featured discussion about the formation of their company and the development of the Flex-1500 Software Defined QRP Radio.

For many of the attendees, Friday is the chance to go up to the Hamvention at Hara Arena and walk the flea market looking for the great deals, parts, wire and other goodies. Thousands of flea market spots and vendors are plenty to keep everybody busy for the day, but the evening is free for more QRP festivities in the ballroom. The Friday night vendor night features even more vendors with QRP related wares, and the voting and judging for the homebrew contests. Once again the vendors, homebrew contestants and seminar presenters are all available for discussion and to ask your questions. The Theatre was used again for a well attended presentation from Elecraft that featured a question and answer session with Eric Swartz, WA6HHQ.

On Saturday evening Four Days in May comes to a close with a formal awards banquet. After a full and delicious dinner, awards are presented to the newest inductees to the QRP Hall of Fame, the winners of the Homebrew Contest and recipients of the QRP-ARCI Awards of Merit. Over 70 prizes were donated from various vendors and members of the QRP community giving everybody a great chance of going home with a prize. After the formal awards banquet comes to a close, the remainder of the evening is a social festivities where friends old and new gather to discuss their newest purchases, gloat about their flea market finds and continue to discuss their newest QRP creations and ideas. As is traditional for many QRP gatherings, Saturday night also features an informal QRP bluegrass and traditional jam session featuring the musically inclined among us.

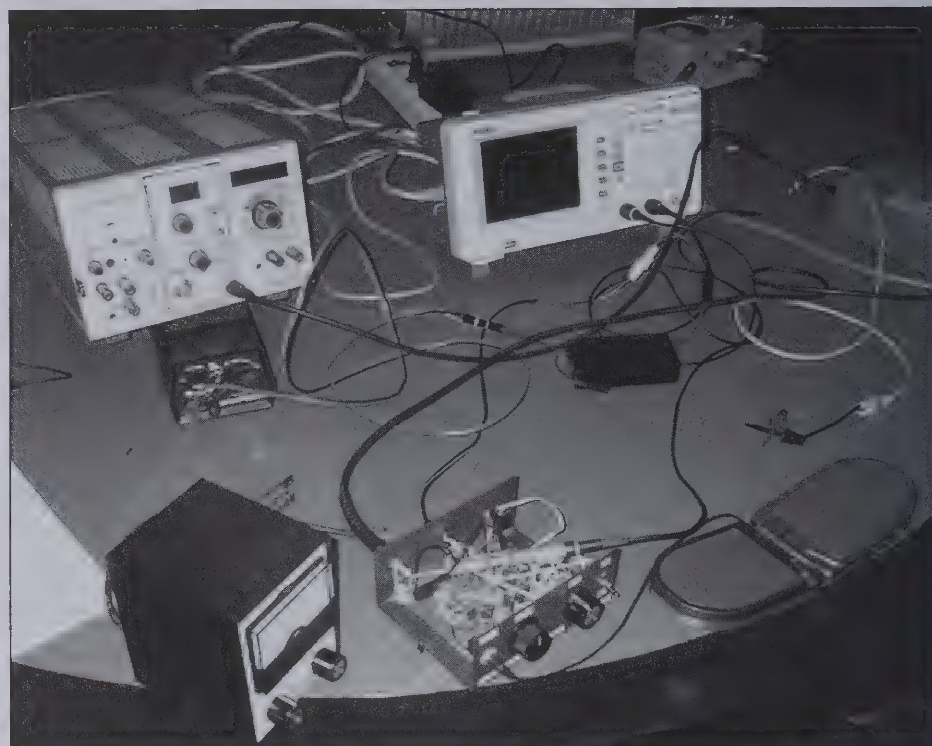
The FDIM "72" Challenge—A Report

Jim Stafford—W4QO w4qo@w4qo.com

Well, the results are in—W4DU is not crazy!

There were many who, when Ken announced the construction contest for FDIM, felt that building a working transceiver with 72 parts (or fewer) was not really possible—certainly not one that was above the crystal radio stage. Yet, as time moved on and the brickbats subsided on the popular QRP lists, it became apparent that it could be done. It helped that one person announced that they had one built and this was within one month of the announcement. So, the battle was on. Others began to express the feeling that they might also build one with 72 parts. Now remember there were some "rules" on this that made the challenge even more of, well, a challenge.

The major details were listed in the "challenge":



Here's the setup for the judges' testing and analysis of each radio.

Design and build a QRP Transceiver using the following rules:

- The transceiver is limited to a maximum of 72 parts.
- The receiver must be a superhet or other "single signal receiver."
- Keying and muting must be included.
- Covers at least one of the standard QRP Frequencies
- Capable of battery power for portable use.
- Schematic w/parts list and functional XCVR be brought (or sent) to FDIM 2010 (13-16 May 2010).
- Only one part may be an IC, all other parts must be discrete components.
- Knobs, sockets, tuning dials, copper board, power source and enclosures are not considered parts.

If more ICs were used, the designer would have to count the components inside the IC in the total of 72. There were a couple of exceptions such as a filament transformer would not count in the total for a tube transceiver!

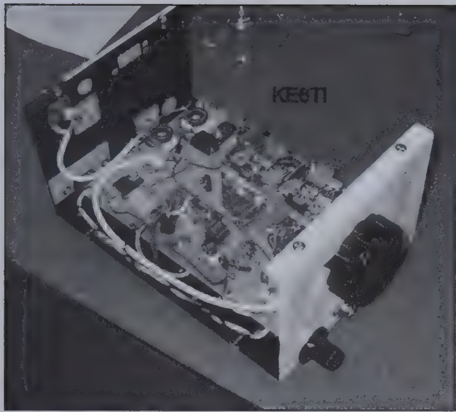
OK, solder was melting, paper shredded, parts ordered. In the end, there were 5 entries in this challenge. This may not seem like many but remember there were probably 10x as many who wanted to enter, did some preliminary design, were too busy at work, etc. The 5 entries were very impressive. Judging for the challenge fell to Ed Hare, W1RFI; George Dobbs, G3RJV; and the author. Well, at least two of them knew what they were doing!

Information in the form of "features" and schematic were forwarded to the judges before FDIM in May. All but one of the entrants brought their transceivers to FDIM. One was mailed in. As you might guess, when it comes to judging, there is about as much time spent on the criteria for judging as the judging itself. Preliminary ideas were to include: features and robustness of design, meeting the criteria and spirit of the challenge, receiver sensitivity, ease of operation (manual vs electronic T/R), output power, and spectral purity were the primary factors.

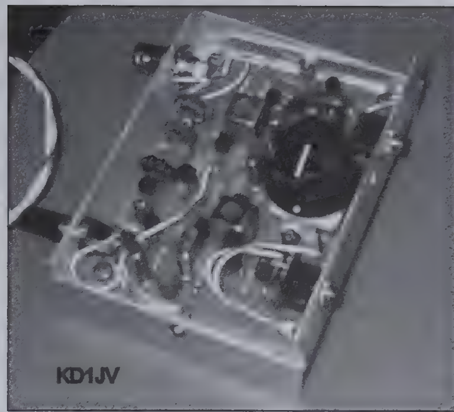
What I'm doing in this article is to provide a summary of the entrants and some observations of the overall designs. I am sure you will see articles submitted by several of the entrants, including this issue of *QQ*.

Let's start off with the entry by Steve Weber, KD1JV. Steve brought in a very small 30M transceiver. It used exactly 72 parts although in discussion Steve feels that a rig with about 100 parts will be a much better transceiver. I'm pretty sure you will see more of the "100" in the near future if not already. It used a PC board, a VXO, had solid state T/R switching, and used common parts. It had an output of about 1/3 of a watt using a 2N4401. Remember that the judges had only a few minutes with each rig and we did not have full lab test equipment but what we could easily bring to Dayton.

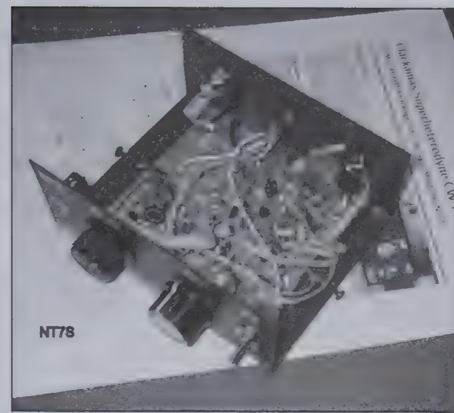
Next we'll look at the entry by Jason Milldrum, NT7S. Jason provided a nicely packaged 40M rig with a VXO to cover 7.030 (+ or –). You'll see more of this rig in an article Jason prepared. It included a two-stage crystal filter. He used a BS170 FET in the final, a device we are seeing more and more of. This rig used manual



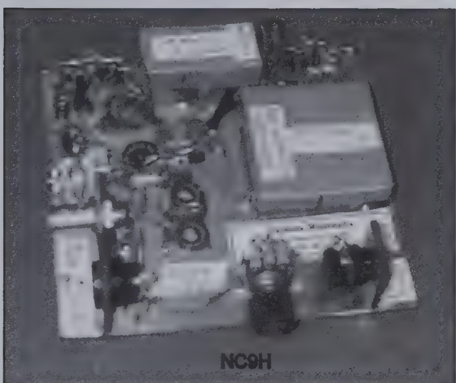
Harold Smith, KE6TI's rig for the 80M band.



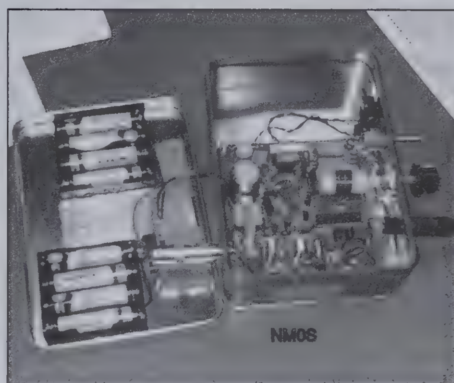
Steve Weber, KD1JV's, 30M transceiver.



Jason Milldrum, NT7S's, 40M rig with a VXO.



40M unit from Jim Roberts, NC9H.



Dave Cripe, NMØS's, 40M transceiver.

T/R switching.

Harold Smith, KE6TI, has been a contributor to *QQ* in the past. His entry operated in the 80M band and had a VFO with an 80 kHz range to it. A Super VXO circuit at 12 MHz generated the signal. The output was in the 2-3 watt range. It is also packaged nicely and had ugly construction inside. A mass produced version would likely use a more tidy layout and shielding.

The next entry is a 40M unit from Jim Roberts, NC9H. His unit had a very clever "dual oscillator" in that the same JFET oscillator was used with two different crystals, switched between transmit and receive. It includes muted keying, offset tuning and a 2N2222 in the output.

The fifth entry came from Dave Cripe, NMØS. Dave has shown his designs are popular and are being sold in kit form. Dave had a 40M transceiver that showed again what can be done with 72 parts. His packaging is interesting and ready for the field with batteries included! Like the other entries, we are anticipating that Dave will share his "secrets" in an upcoming issue of *QQ*.

Obviously, it was difficult to judge such a great set of entries in such a short period of time (it still took over 2 hours) and compromises in the testing had to be made. It was apparent that each rig had certain limitations or deficiencies compared to what we have come to expect in a fully usable rig. However, that would be expected in a competition such as this. Each contestant could have used more time, more parts, more money or all of the above. The restrictions were real and each designer felt (based on their comments) that they would have liked to do a bit more in each case.

Some of the features/functions that were subject to compromises in one or more entries included:

1. Tuning range
2. Power output
3. Ease of use
4. Spectral purity
5. Selectivity

But what would we expect from such a challenge—a K4? Not at all! Is the perfect dinner prepared in the Food Network Challenges? No, they do the best they can with the time available. Still and all, some great entries with some clever ideas were submitted and very much appreciated by the judges and by the attendees at large during the Friday night "viewing."

In the end, the decision of who won led us to the KE6TI entry. Congrats to Harold. But we were unanimous that all the other entries deserved second place. That let the judges off the hook, but it was a very logical conclusion. First place picked up a \$100 bill and the others a \$50 bill so each could continue their future of RF design and be ready for the 2011 FDIM Challenge.

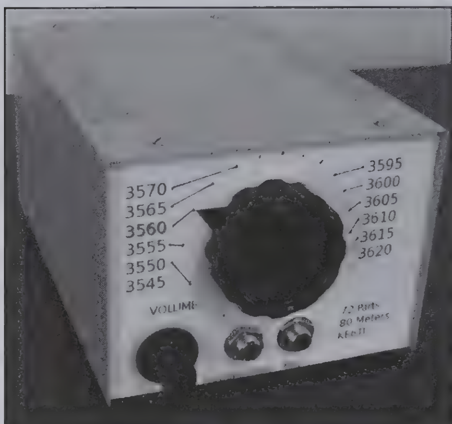
See the designs from KE6TI and NT7S in this issue of *QRP Quarterly*!

Others will be published in future issues...

A Radio for the FDIM 72-Part Radio Challenge: A Study in Trade-Offs

Harold Smith—KE6TI

harold.smith1@gmail.com



I first heard about the QRP-ARCI's 72-Part Radio Challenge in mid December, 2009. The task was to design and build a complete radio transceiver, with a single-signal receiver and T/R switching, using no more than 72 parts, only one of which could be an Integrated circuit (IC). I was immediately intrigued, and spent the next few days thinking of not much else. (Ask my wife.) Pretty soon I had sketched out a couple of possible radio configurations.

I looked at building a radio with a crystal-controlled transmitter, wherein only the receiver would be tunable, but that felt to me too easy and not really in keeping with the spirit of the challenge. I thought about using a phasing scheme with a direct-conversion radio, but that felt like too many parts. I soon decided that I would tackle a full super heterodyne radio, with transmitter and receiver controlled by the same master oscillator, which would be variable over at least some range.

Superheterodyne transmitters, though, have issues with signal integrity, since they contain more than just a single frequency and its harmonics. That meant I would have to do some filtering, and filters use parts, too.

That, in turn, led me to decide to build the radio for 80 meters. My thinking was it would let me put both the intermediate frequency (IF) and the variable frequency oscillator (VFO) frequencies above the operating frequency, which, I hoped, would let me get away with using only low pass filters in the transmitter. That should have led to a fairly simple transmitter, which should have left me with lots of parts with which to build a receiver.

I now had a rough idea, and a first-pass block diagram. I started thinking more about the details.

I began by working on a frequency scheme. For stability, I wanted the VFO as low as I could get it, but high enough that a decent low pass filter would strip it out of the transmitter's output. I guesstimated that it would have to be at least 7 MHz, which would put the IF about 3.5 MHz higher. Unfortunately, I didn't have a supply of crystals in the right range, so I swapped IF and VFO. I have a good number of crystals at 8 MHz, so I tried to build a VFO at 11.5 MHz.

Alas, I could not get any simple VFO circuit to be satisfactorily stable at that frequency, and I tried several. So I decided to try a variable crystal oscillator (VXO). This choice further limited my choice of IF, since I had to have crystals at both the IF and local oscillator (LO) frequencies.

I settled on 12.0 MHz for the VXO and 8.385 MHz for the IF. I have hundreds, possibly thousands, of crystals at 8.385, so I knew I would be able to come up with a matched set. I only had a few at 12.0 MHz, but I only needed two for a Super VXO (SVXO). The SVXO is a circuit devised by a Japanese ham that uses two or more crystals in parallel to increase the pulling range. Going from a conventional VXO to an SVXO only cost me one additional part, and gave me a huge increase in tuning

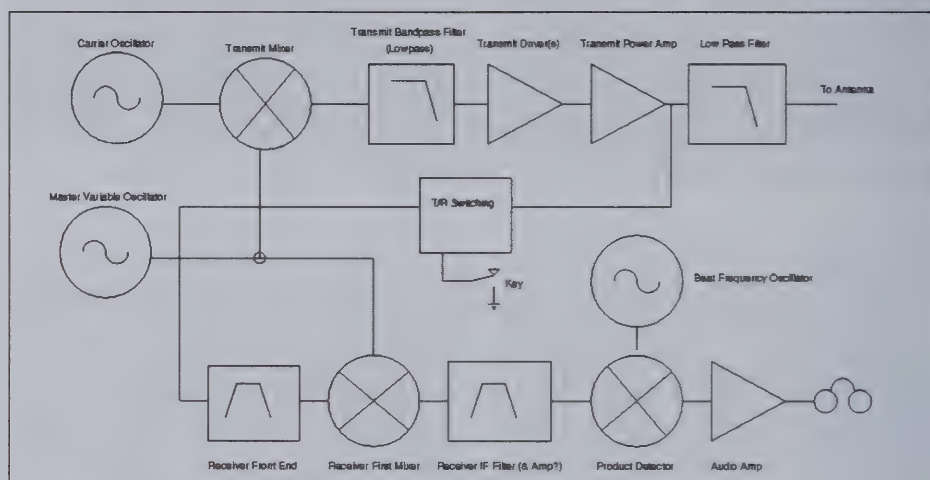


Figure 1—Initial block diagram.

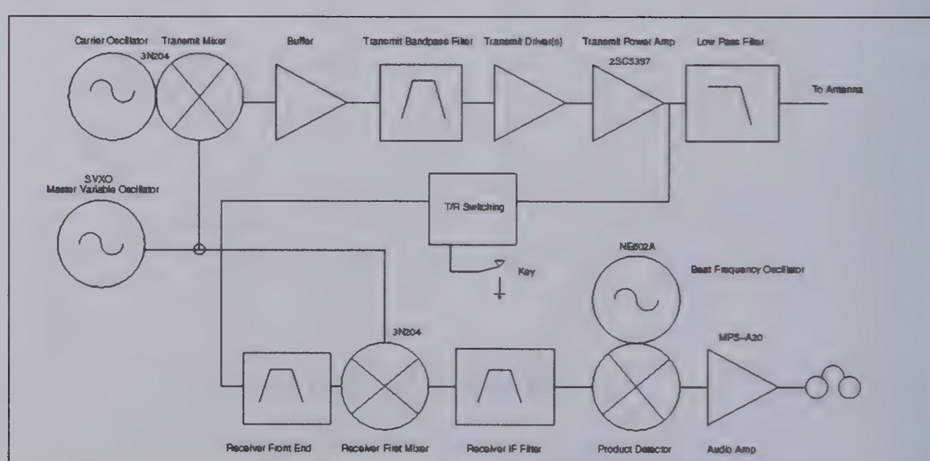


Figure 1—Final block diagram.

range. The SVXO as built covers about 80 kHz, with crystal oscillator stability. And since I knew I would be driving high impedance mixers, I felt I could get away without a buffer stage.

The SVXO uses one section of a multi-section variable capacitor. I chose that capacitor because it has a very nice, almost-two-to-one reduction drive, which spreads the tuning out over almost 360 degrees.

To try to eliminate even the coupling capacitors, I replaced the usual RF choke in the source with a transformer, which both lifted the source above ground and AC coupled to the load. Transformers, in general, turned out to be a great way to reduce parts count.

I also determined that the use of field effect transistors (FETs) and direct coupled circuitry where possible would allow me to use a minimum of biasing components. (Ultimately I needed only 12 resistors in the entire radio.)

Usually when I build a radio, I start with the master local oscillator, whether free-running or crystal controlled, then I build the receiver. In this case, though, I felt the transmitter would be more difficult, so I built it next. Since it would be a heterodyne design, I knew cleaning up the output would be important, and I was concerned that doing so would eat too many parts.

I chose to try using a dual gate MOSFET, a 3N204, as a combined carrier oscillator and mixer, though I was not sure I could make it work. It took a little tweaking, but I did eventually get it working. Getting it working required adding some DC bias to gate 2 of the device, which meant I needed a second secondary on the SVXO transformer. The cold end of that winding goes to the 5 volt rail rather than ground.

That 5 volt rail, by the way, comes from a three terminal regulator. Such parts are, of course, ICs, but in this case the challenge rules specifically stated that regulators were considered discrete components. If they had not been, I would have used a resistor and Zener diode to get the power for the SVXO and the NE602 (my official IC), at the cost of one extra part.

After the mixer, I had hoped to be able to use a low pass filter to select the desired output and reject the rest. A few tries, though, made me realize that it wouldn't work, at least with the minimal filters that I tried. So I reluctantly looked at band pass filtering, which I was afraid would need

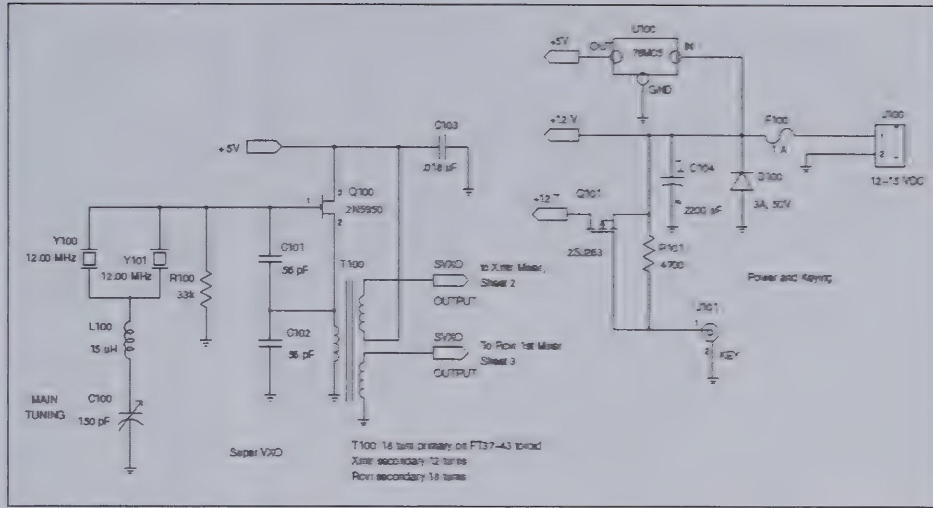


Figure 3—The final SVXO circuit.

even more parts.

Here, though, as in the SVXO output, the transformer came to my rescue. A single, two-winding transformer, T200 in the schematic, serves as both of the inductors in a dual-resonator filter, as well as the coupling between them. The band pass filter ended up using only three parts. (You old-timers will realize I simply reinvented the IF transformer.) The transformer primary is tapped to allow Q201 to couple to it without loading it severely. As it happens, the secondary is also tapped, but that tap ended up being unneeded.

I tried to get away without Q201, but the mixer itself didn't quite put out enough drive, and using a PNP where I did allowed another stage of gain that consumed only two additional parts. I also tried coupling out of the filter to a single transistor driver, which I hoped I could run class C, to require a minimum of biasing parts, but that didn't work either. I ended up with the FET-PNP pair which added four parts but made the transmitter work.

All of the junction FETs used in this radio are 2N5950 types. I chose that part specifically because it is much more tightly specified for I_{DSS} than any other inexpensive FET, with a range of 10 to 15 mA. This allowed me to use them interchangeably, without having to re-bias each stage as I built it. It is a good RF part, selected from the same die source as the 2N4416 and 2N5485 families, and no more expensive.

The final amplifier is a conventional class C stage, with transformer coupling both in and out. A transformer is one part, whereas a choke and coupling cap are two parts. I tried eliminating R207, the resistor from base to ground, but the final showed a bit of instability without it. I did make it as large as I could, to make as much power available to the final as possible.

The five element low pass filter is almost conventional. It came from the tables in the back of the *ARRL Handbook*.

Once I had the transmitter working, I could get to the receiver, with a clear idea of how many parts I had available. I did not think it would be enough.

The first mixer is another 3N204. Since it did not have to oscillate, I hoped I could get away without the gate 2 bias, and, fortunately, I could. In fact, that stage has no bias components at all. The source is directly grounded, and both gates are at DC ground through their respective transformer windings. The drain resistor serves to terminate the input of the crystal filter.

Next I realized that I did not need a fancy front end for the receiver. Instead there is a simple transformer to step up the signal to the 3N204's gate. There is no RF filtering for the receiver beyond the same low pass filter that cleans the transmitter output. The RF image is at 20.385 MHz (8.385 + 12.0), so a low pass filter with a 4 MHz cutoff suppresses it nicely. Notice that, in receive, the filter is only four elements, as C207 becomes a coupling capacitor. It still works fine for the purpose.

After the mixer comes the crystal filter. Usually when I build a receiver, I start with a known filter. But in this case, I wasn't sure how many parts I would need to make the rest of the receiver, so I started with a

single crystal between the first mixer and the product detector. I felt I could always add to it if I had parts to spare.

I used my one Integrated Circuit (IC) in the product detector and Beat Frequency Oscillator (BFO). I used a common NE602A (now called the SA602A by its manufacturer). I knew going in that the one IC would have to perform more than one function in order to justify itself. In a simple receiver like this, the 602 is hard to beat, combining mixer and oscillator on one chip, and with good gain as well.

I had assumed all along that the audio output would be intended for headphones, since that is how I build most of my radios. Even so, I started with a two stage, direct-coupled audio amp, consisting of a gain stage and an emitter follower. Eventually I realized that if I restricted output to high-impedance headphones, which are what I use anyway, I could eliminate the follower. I did use an MPS-A20 transistor in the audio stage, because it is capable of very high gain at low noise in the audio range. It gets its base bias from the NE602's output, and its collector load resistor is the volume control.

At this point I was delighted to discover that the receiver had better sensitivity than I had feared, easily hearing a 1 uV signal from a generator. Selectivity would have to wait a bit, though, because the radio still needed a Transmit-Receive (T/R) switch to allow break-in keying, or QSK.

I started with a conventional series-tuned LC network, with a MOSFET switch in the middle between the C and the L. The C was half of the first capacitor in the transmit lowpass. It worked, but it ate a lot of parts. Eventually I pared it down. That first

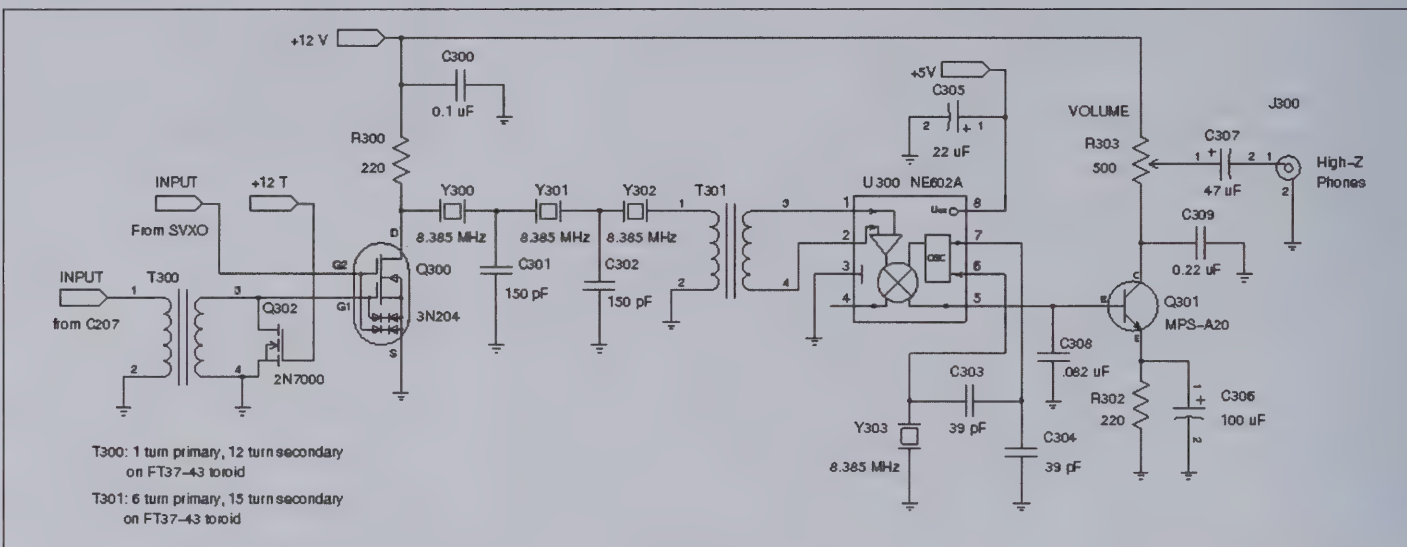


Figure 4—The 72-Part Challenge receiver circuit.

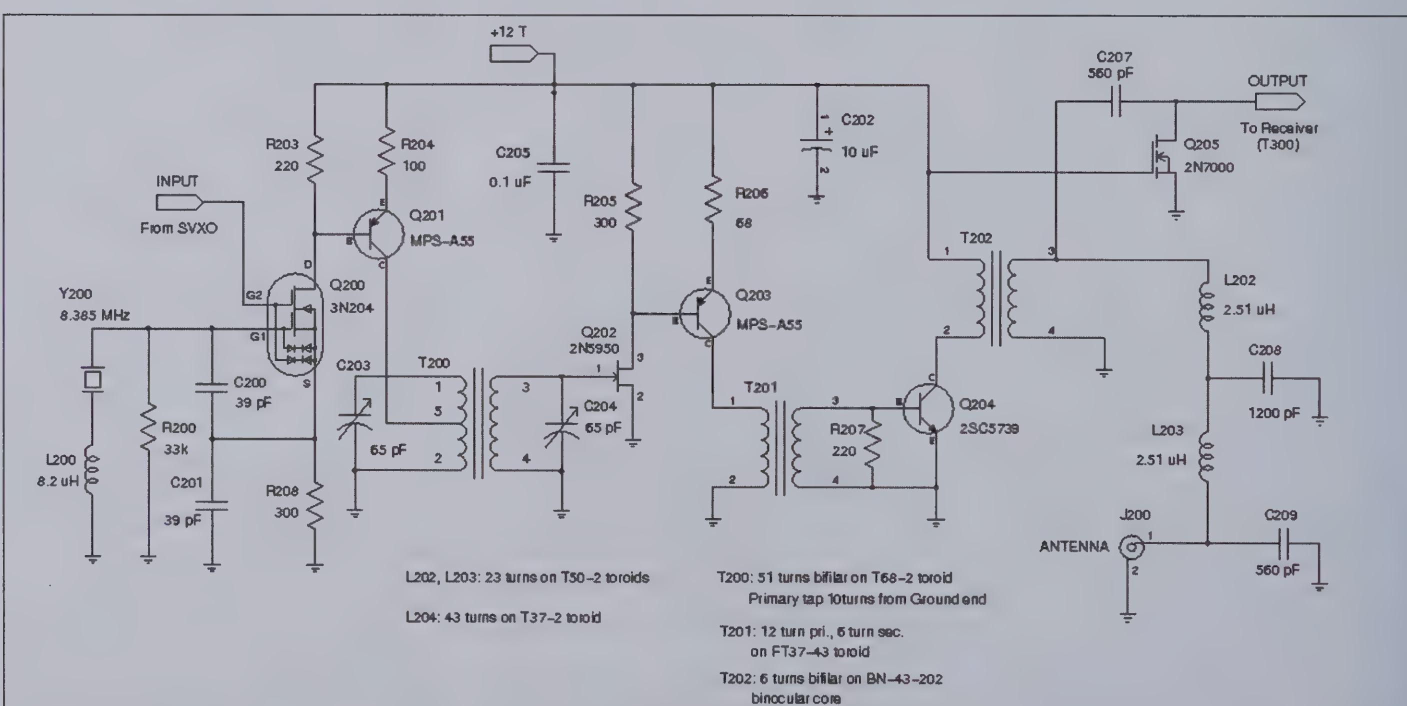


Figure 5—The transmitter circuit final design.

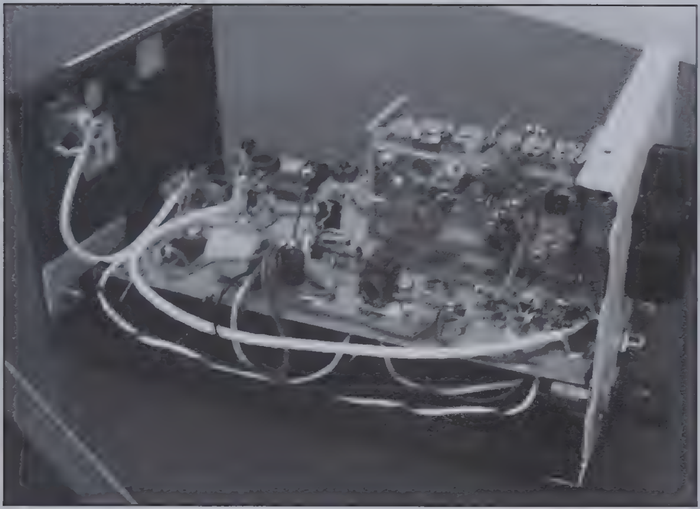


Figure 6—View from the receiver side.

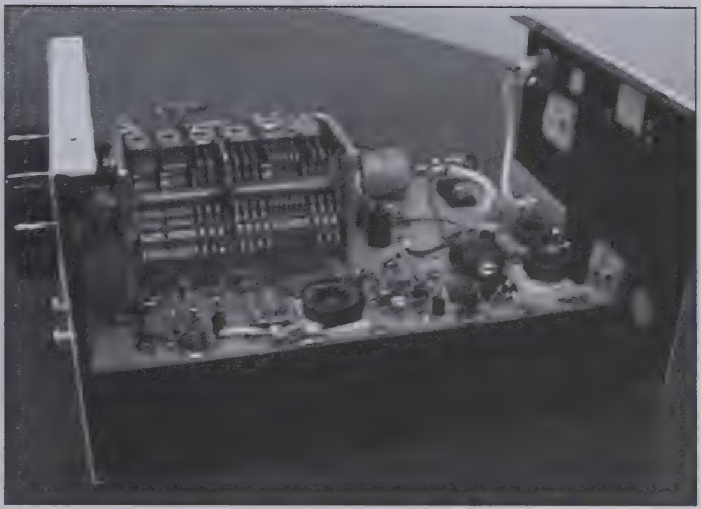


Figure 7—View from the transmitter side.

capacitor, C207, now serves in the receiver as a coupling cap. In transmit it is grounded by Q205, a 2N7000 MOSFET. The series inductor in that network is gone, and in receive C207 connects directly to the mixer input transformer. For better muting, a second 2N7000 grounds the secondary of the receiver's input transformer. Enough of the transmitter's RF still gets into the receiver to serve nicely as a side tone.

In transmit a 2SJ263 P-channel MOSFET is turned on by grounding its gate with the key. It supplies power to the transmit chain and the gates of the muting MOSFETs.

A fuse along with a rectifier diode, protect the radio from a reverse polarity power source, and the fuse should protect the power source from a short circuit fault in the radio.

With all the other circuitry built and tested, I was able to boost the IF crystal filter to three crystals, giving acceptable, if not world class, selectivity. The peak of the filter is a few hundred Hz wide. It is the skirt selectivity that is less than perfect. Still, the receiver sounds good.

The transmitter puts out about 3 watts with a 13.5 V supply. The receiver delivers a 10 dB signal to noise ratio with a 1.5 uV input signal, as measured in my shop (using a signal generator that probably hasn't been calibrated since WWII.) The radio draws approximately 40 mA while receiving and 400 mA transmitting.

The filters and those amplifiers for which I had decent models were simulated using SPICE, specifically the free demo version of Simetrix, which has my favorite user interface among the SPICE packages. I did not have models, though, for the 3N204s, so those circuits were pretty much completely empirically designed. And I have yet to find a way to analytically design an SVXO. I always have to built it and tweak it to get it working the way I want.

I built the radio ugly style, as I do pretty much everything I build these days. It goes together quickly, has excellent RF characteristics (great ground and minimal parasitics) and is just easy. It is not especially pretty, which is why it is called "ugly style." I did package the radio in a nice box that originally held some other bit of electronic apparatus. Most of the parts are mounted only by their leads, but a few are also held in place with double-sided tape, for a little extra stability in a radio I knew would get a lot of handling.

The front panel I printed on an Avery 8126 White Shipping Label. I drew it on the computer, and made a couple of test passes on ordinary paper first, then printed on the label when I was happy with it. The Avery labels are not only self-adhesive, but have an opaque lining that allows no light to leak through, thus hiding several extra holes in the recycled front panel. The Avery label was the only thing I bought specifically for this radio. All the other parts came from my junk box, on which I have been working for almost half a century. (Ask my wife.)

This radio was a very enjoyable challenge. I spent a lot more time designing and tweaking the design than I usually do on a single band radio. In the end, the biggest contributors to the minimal parts count were transformers, FETs, direct-coupling and lots of corner-cutting. I did a few things that I would not ordinarily consider doing. For instance, I did nothing to control the rise and fall of the keyed transmitter's output, which I hope sounds okay on the air. Rise time is about 3 ms, which should be okay, but fall is less than a millisecond. No one has actually complained yet, but the radio has only been on the air a few times.

I will be the first to admit that, though it works, and fairly well, this radio is definitely a compromise design. Ordinarily I would have used more filtering almost everywhere: the receiver front end, the IF crystal filter, the transmitter band pass. I got away with the minimum, but I would not recommend it generally.

And if anyone wants to try to duplicate this radio, I definitely recommend adding a few parts to decouple each stage from the others. The entire transmitter has only a single RF bypass on its power rail. I got away with that through careful layout, and because the ugly-style construction I used gives such a good ground plane. There was probably a large dollop of plain dumb luck involved, as well. However, such minimal decoupling is absolutely not what would be considered good practice.

Thanks to QRP-ARCI for the fascinating design challenge. I enjoyed designing and building this radio more than any other in a long time. I will be happy to answer any questions, or entertain any comments about the radio.

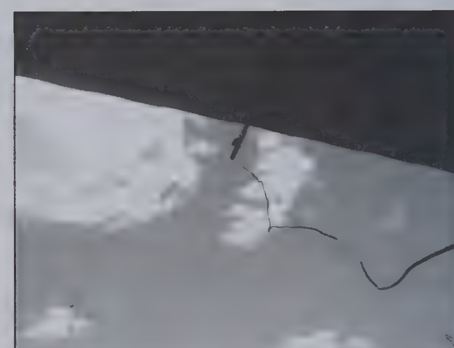
Enjoy QRP Without an Antenna

Oleg Borodin—RV3GM rv3gm@mail.ru

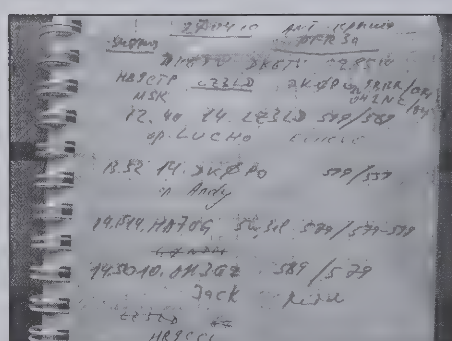
Oleg, RV3GM.

Olga, RA3GKB.

Our villa.



Wire with "crocodile" clip attached to the metal roof.



My log using "no antenna."

SU-32 fighters fly overhead.

Always I like to try unusual or extreme QRP contacts such as operating radios consisting of just a few components or using the simplest antenna. As my wife Olga (RA3GKB), says "Any fool can operate good radio with good antennas, try to do it with poor one!"

We have a small suburban house with a garden; I call it "villa." In the spring there is lots of garden work, and I have not enough spare time for QRP or portable. One April day I have brought my PFR-3a transceiver to our villa, hoping to make a couple QSOs during time outs. Since there is a lot of work in the garden, I had not installed my usual 40 and 20m inverted-V antenna at eight meters height.

Instead of an antenna I connected a piece of wire with "crocodile" clip direct to the house metal roof. It is made of some metal profile sheets reliably connected to each other with zinc screws. The roof size is 50 square meters approximately.

So, I connect the roof to the "Balanced line" terminal of my PFR-3a. As counterpoise I used a 5 meters of wire connected to the other "Balance" terminal. What a nice Z-tuner the is in the PFR-3a transceiver! It matched my "super-antenna" on all bands as the SWR LED dimmed. To tell the truth, I was not sure that even pair of QSOs will be done with such a poor antenna system.

Firstly, I tried to call any loud stations on 20m band. After some unsuccessful attempts LZ3LD replied to me and gives me RST 569. I was pleased very much and went to tell about my luck to Olga. She laid down some flowers and told me: "I spoke that any fool can operate with the good antenna!" I agreed and helped her in the garden.

After an hour I returned to the radio and soon logged DKØPO. Op Andy sent me a 559 report. Being assured of the "antenna" I began to transmit CQ on 14060 kHz. My old friend Laci HA7UG/qrp called me. He operated 5 watts to 3 el SteppIR Yagi antenna and gives me 579 to 599 QSB report. I explained about my "super-antenna" construction and he laughed.

Feeling enthusiasm, I QSYed to 30 m band and sent CQ once. OH3GZ responded fast and give me report 579. Next QSY on 40m band but there are no stations at daytime, sorry.

So, you can see, even using a roof instead of normal antenna, it is possible to operate QRP. Four contacts with four countries, even one of them is two-way QRP. I think, it is not so bad result for "no antenna" portable QRPing! There is no electricity at our garden house. I powered PFR-3a by large 7 A/h 12 V rechargeable battery. Thanks to the good antennas and good ears of my correspondents I have successful QSOs.

For the final a little note. Some "birds" flew above us that April day. An Air Force aerodrome is located less than a mile far from our villa. Some fighters SU-32 trained before a Moscow Parade devoted to WW-II Victory Day. A beautiful air show, nice portable QRPing, sunny Spring day—what more is necessary for full happiness!

72 for everybody and see you on a QRP frequency soon!

Software Defined Radio for Newbies

Pete Juliano—N6QW radioguy@hotmail.com

Several months ago while researching a homebrew 20M QRP SSB transceiver project that was published in the early 1970s, an email exchange with the author resulted in my being introduced to Software Defined Radio (SDR). The author clearly stated he had transitioned from homebrew analog type radios to the new SDR technology. Actually, I think his real motive in bringing up the subject was that he wanted to do some shack cleaning or generate some cash for a new toy. He made an offer to sell to me an operational Soft Rock V6.2 RxTx SDR transceiver for the mere sum of $50 plus postage. Wow! How could I refuse? Little did I know that I was opening Pandora's Box!

When the radio arrived it was in a very small box and I had a sinking feeling that I somehow misunderstood the deal. Well sure enough, it was a complete transceiver on a circuit board roughly 3 inches by 4 inches. This is where the fun began!

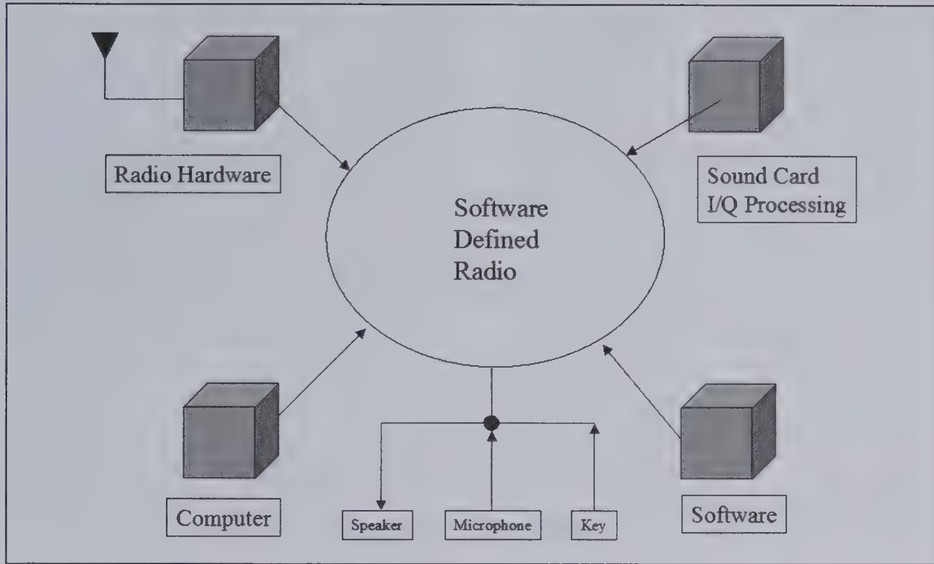


Figure 1—Software defined radio block diagram.

Let the Journey Begin

What I didn't realize when I started this odyssey was how little I knew about software defined radios, what makes them tick and how to make them work. I started the process as I usually do by hooking up the hardware and pushing buttons. But when I applied this approach to SDRs, it produced very little in the way of useful results and brought me to the realization that implementing an SDR is a bit more than "plug and pray"!

In retrospect, I should really have begun by spending a good deal of time collecting information and data on SDRs. Next, I should have spent a lot of time reading and understanding the information and the very last thing should have been touching the hardware. That point brings us to one of the real purposes of this article, which is to try to provide an overview of resources and detailed information so that the readers who are contemplating a move to SDR will have a solid foundation regarding on how to approach this task with a minimum of effort.

I cannot over emphasize the importance of getting up to speed on SDRs, or if you prefer going down the learning curve, before you attempt to make any one of these radios play. I would also like to suggest setting up a filing system to organize the gathered information. Typical sub files might include collection points for hardware related information. Another might be software and still another for documentation on sound cards. I made the mistake of using one file location and now I can't find anything! Trust me. Do this first and it will save you a lot of grief later on.

As a starting place that is less technical and more practical, I would like to suggest visiting the following website for some excellent information on SDR basics. http://home.ict.nl/~fredkrom/pe0fko/g8voi/SDR_1.pdf Bob Reeves, G8VOI, prepared this information and I think is a good starting place for understanding SDRs. Bob is s super guy and most helpful.

Once you have mastered the basics, you should take a look at the articles that started the use of SDRs in amateur radio. Gerald Youngblood, K5SDR (formerly AC5OG), founder of Flex Radio Inc. started the current revolution in the use of Software Defined Radios through a series of four articles that initially appeared in the July/August 2002 issue of *QEX*. These articles can be found at http://www.wb5rvz.com/sdr/ and form the basis of how the Flex Radio SDR transceiver was developed and how it operates as it does. These articles are quite comprehensive and detailed. They are a must read but highly technical!

Next I would suggest joining the several reflectors that deal with the most commonly available SDR kits. Three of the more popular reflectors (which require that you join these groups) address a specific SDR radio. These are:

Softrock40 http://groups.yahoo.com/group/softrock40/

Power SDR-IQ http://groups.yahoo.com/group/powersdr-iq/

Mobo Kits http://groups.google.com/group/MOBOKITS?hl=en

The real value of these groups lies in two aspects. The files and prior posts have a wealth of information about setting up SDRs, what worked and what didn't and secondly you have the ability to post inquiries regarding issues or problems that you may be having.

But before you begin this reading and reflector "lurking," let me tell you a bit about the SDR process so you will have an overview of what you are reading.

A Little Theory

In order to understand the SDR process see Figure 1, which depicts the elements that essentially comprise a Software Defined Radio. I like to think of these

blocks as four legs of a stool. For the stool to be balanced each leg plays an equally important part in the process. The first leg is the radio hardware (which by the way typically is all on one small circuit board). The second is the software, which thankfully is a free download from several sources. The third is a relatively powerful computer to process the signals and the fourth leg is a better quality sound card. The first two legs seem simple enough. But don't be fooled as the software is very powerful and complex in that it employs mathematical algorithms to perform digital signal processing (DSP) by employing math operations known as Fast Fourier Transforms (FFT). The last two legs bring on a whole new array of challenges. While I had indicated that each leg of the stool plays an equally important part in a SDR, the computer, software and the soundcard determine a large part of the ultimate performance.

To fully appreciate the impact of the Computer and the Sound Card, let us explore what happens in the SDR process:

The radio hardware itself is fairly simple, as it simply receives the RF signals and translates them to a frequency range which is suitable for computer processing. A local oscillator (LO) operating at four times the signal frequency (some current designs also operate at 2x) is mixed with the RF signal to create a near-baseband signal that can be used by the computer and sound card. A pseudo IF frequency of 10 kHz is frequently used. Mixing occurs in a Quadrature Sampling Detector (QSD) that ultimately creates two signal channels. The QSD is the brainchild of Dan Tayloe, N7VE and is also known as the Tayloe Detector. Four outputs result from the QSD process, each 90 degrees out of phase with each other. The 0 and 180 degree outputs are summed in hardware as is the 90 degree and 270 degree outputs. These four outputs now become two channels that are 90 degrees out of phase with each other.

One of these channels (0/180 degrees), being "in phase" with the LO, is known as the I channel and one that has a 90 degree phase shift (90/270 degrees) is known as the Q channel (Q = Quadrature). Essentially, the RF signal has been converted to two baseband signals in the audio range, with the two signals with a 90 degree difference in phase between them. Theory tells us that these two signals contain independent information on the original RF signal, and together form all of the information available on that RF signal. Hence if they are digitized at a rate greater than the bandwidth and fed into the computer via the sound card, any further processing can be accomplished in software.

The transmitting process uses similar hardware to create signals in a Quadrature Sampling Encoder (QSE) which essentially is the reverse process of the QSD.

Even though the hardware function is simple, there are still some properties of the radio hardware to be considered. Chief among these considerations is a need for good dynamic range. Typical hardware bandwidths are about 20 kHz, and any large signal appearing in that bandwidth could cause distortion and introduce spurious signals. If the hardware possesses good dynamic range, the chances of producing this distortion are lessened.

As the name implies, SDRs do all the information display, hardware control, filtering and other processing in a computer with some very powerful software. There will be more to say about this software a bit later. The important point to consider now is that the time to do this processing is limited by the sampling rate of the sound card. Typically, a sound card produces an I/Q sample pair at 48,000 to 96,000 times per second. If the software is to keep pace with the incoming signal samples, then it must process each sample pair in about 10 to 20 microseconds while also providing display and control functions for the human operator. The ability to do these computations in the necessary time brings us to the last two legs of our four legged stool—the computer and sound card.

Most readers of QRP Quarterly, being true hams, will be tempted to use a computer and sound card they already have on hand. Thus if one has an old 300 MHz Sony laptop lying about, the immediate question would be would this work? I can only give you a qualified "possibly" but most likely you will overwhelm the computer. You will hear claims from some hams that they have achieved great signal reports using these older computers. I can only say from my experience that you need something with current state-of-the-art capabilities.

In my case, I started with a 2.4 GHz Toshiba Laptop, vintage 2005, which I already owned. I found from my reading (and experience) that the internal sound card lacked the necessary muscle, so I equipped it with an external USB sound card (EMU 0202, 24 Bit, 96 kHz) for I/Q processing. I found that the CPU usage was running around 80 to 90%; so that computer was really struggling and there was not much headroom.

In April 2010, I switched over to a desktop computer that is now dedicated to SDR. It is a computer I built and uses a Pentium 4 running at 2.6 GHz in the hyper-threading mode. It has 2 GB of Memory and the OS is Windows XP Professional. The CPU usage is now averaging in the 40 to 50% range, which gives a lot more headroom than the setup with the Toshiba Laptop. With the extra headroom, I can do much more in the way of experimenting and adding software that will improve overall performance. Thus I can say first hand that for in-shack operations the desktop is my first choice.

If a more portable setup is required, I can go back to the laptop at the cost of reduced performance. There is a big difference in performance between the two setups, even though the software and radio hardware have not changed. So the message here is to think carefully about what you will be using and resist the temptation to use any old computer that may be lying about. To put this into perspective, assume it is the middle of winter and you have a choice of driving from LA to New York in a vintage 1959 VW Bug or in one of the new hybrids. Will both cars get you there? Maybe, but you probably would see better performance, have far fewer problems and a have greater likelihood of actually arriving in New York with the more recent vintage automobile.

The remaining consideration with respect to the computer is a choice of operating system (OS). The OS of choice seems to be Windows XP Pro although many are using Vista and Windows 7. There have been some issues with the SDR software and the use of Vista and Windows 7 (the 64 Bit version); but in typical ham fashion these are being worked on across the globe. Linux is also receiving some attention and may eventually be a major player. Beginners might want to choose XP Pro, just to play it safe.

Saving the best for last, let's now talk about sound cards. First, we need to consider the sampling rate afforded by the

card. I/Q sample pairs must be created at a minimum rate equal to the input bandwidth, and in practice a somewhat higher rate is typically used. Second, we need to think about the number of bits/sample. A higher number of bits/sample affords us better dynamic range, the ability to handle both large and small signals simultaneously without distortion, masking or the formation of spurious signals. So, sound cards with higher sampling rates and more bits/sample result in more capable SDRs. As you might guess, these types of sound cards also cost more and are seldom included with the PC when you buy it. Typical sound cards with "better" performance are those with 24 bits/sample and sampling rates of 96 to 192 kHz. Last but not least, the brand and model of the sound card is important. This is because the PC is being asked to accept the sound card samples in real time and process them very quickly, thus demanding a very careful interface between the PC and its sound card. This often means that a particular set of software will support specific sound cards. If you download the software from a website used to promulgate and support the software, there will almost always be a statement somewhere on the website concerning which sound cards are supported. Unsupported sound cards may be used but if trouble ensues you are on your own. I can say from experience that, as a beginner, it's better to play it safe and avoid the expense of possibly having to replace a high-end sound card.

So with that bit of theory out of the way, let's survey some of the SDR-related products that are being offered.

SDR RF Hardware

Thanks to the inventive and creative spirit of the ham radio community, it was not long after the first commercial SDRs hit the market that several hams offered inexpensive kit SDRs for sale. These kits were being sold at very low prices so that hams could get a sampling of the power of the SDR radios with a minimum investment.

The early SDR kits used a fixed frequency crystal oscillator for the LO and depending on the sound card, a slice of frequencies could be tuned on either side of the LO depending on the bandwidth of the card. A 96 kHz sound card used with a LO that results in a 7.050 MHz center frequency would give a tuning range from 7.002 to 7.098 MHz. The current crop of single band SDR receivers are being sold in the $15 range. So this is not a huge investment for a high performance receiver and an excellent place for the SDR newbie to start. However, these inexpensive kits must be hand built and many use surface mount devices (SMDs). So as much as you like using the Radio Shack 80-watt soldering iron it does not work too well with SMD parts. Thus a soldering iron designed for SMD and a little practice is needed before tackling some of the more sophisticated kits. The $15 single band receivers are really the place to start.

One of the most popular and widely discussed series of single-band SDR receiver kits are the Soft Rock series of radios produced by Tony Parks, KB9YIG. Tony's site is www.kb9yig.com and this is "the place" to acquire SDR hardware. If you visit the site, you will see the product offerings with the note "check back soon." Tony has produced tens of thousands of kits and they go like hot cakes and sell out in hours. So frequent checking of the site is necessary. I understand there is a software program that will poll his site literally on a minute by minute basis and will notify you when anything has changed. That seems extreme but may be necessary to get your hands on some of the most highly coveted hardware. What you get from KB9YIG is bags of parts. This is not a Heathkit! Tony's kits are under constant revision to add refinements and functionality.

Another of the most popular kits has been the V6.3 RxTx SDR 1-watt transceiver. This unit comes with the Si570 frequency generator/synthesizer, and four plug-in receiver band pass filters that cover 160M, 80/40M, 30/20/17M and 17/15/10M. Separate plug-in PA filters are sold individually for the same four bands. To make this an operating radio all that is required is one set of PA filters and one of Tony's USB to I2C interface plus the interface connectors. The USB to I2C interface is required to control the Si570. This kit was retired in April 2010 and has been superceded by a model known as the Ensemble which should be available sometime in June 2010. This new offering includes all of the interface connectors that are mounted along one of the edges which really facilitates the interconnect process.

Hams are always in search of the better mousetrap and so it is with an international group of hams who are marketing what is called a MOBO Kit. This essentially is a plug in board that rests on top of Tony's V6.3 RxTx and turns it into an all band SDR transceiver with electronic bands switching, an RF amp booster, all the necessary filters and a monitoring system to look at critical parameters. It is quite impressive. Details and information can be found here. http://groups.google.com/group/MOBOKITS?hl=en

A ham in Canada is also producing a clone of Tony's V6.3 RxTx, albeit different since it uses virtually all SMDs with the intent that it be used with the MOBO Kit. That said, the Canadian kit does not come with any Rx or PA filters as it would rely on the MOBO kit for those items. However the clone kit has been designed so that it can be operated independently and will accept the same filters used in Tony's radio. See http://groups.google.com/group/MOBOKITS/web/sr63ng-information for details and ordering information

Robby WB5RVZ has taken on the chore to document the various builds of Tony's kits and in one word is outstanding for being detailed, comprehensive and accomplishing the build in a logical test as you go approach. This is on par if not better than the Heathkit as Robby updates the documentation literally on the fly. You can find this documentation at www.wb5rvz.com . Also on his site are other reference documents to SDR theory and applications. He has also documented the build of the Mobo kit.

There are several other hardware offerings. These include the Genesis SDR kits from Australia and these can be found here http://www.genesisradio.com.au/G3020/index.html. Dave Chambers WB6DHW has also produced a kit with a slightly different approach to the SDR process and this can be seen at http://wb6dhw.com/For_Sale.html.

Finally, FlexRadio, Inc (www.flexradio.com) markets and sells ready-to-operate SDRs ranging all the way from entry level QRP SDRs to high end radios complete with a built in computer. FlexRadio has made their software open source and so as hams we benefit by having access to the same software that drives their amateur and commercial products. FlexRadio maintains a Knowledge Base that is outstanding and while aimed at their

products it covers much of the same ground that will be used in other SDRs. FlexRadio has covered one item in particular that would be useful from the onset and that is the characterization of what computer hardware works best with SDR. The 300 MHz Sony laptop is not included in that discussion.

And of course, you could always "roll your own" SDR transceiver. They are fairly simple after all. The receiver is mostly an RF amplifier at the front end, followed by a mixer and local oscillator and a minor amount of amplification in the audio range. The transmit portion is simply the inverse configuration—a mixer/local oscillator followed by a power amplifier and filters. Filtering and processing all happens in software. If you should decide on this approach, the local oscillator will be the key to a successful homebrew radio. Fortunately, Silicon Labs has produced a marvelous frequency generator chip known as the Si570. This chip will probably end up being the 2N2222 or 2N3904 of the synthesizer chips. Most recent designs employ this chip as the source for the LO versus the fixed crystal oscillator.

The Si570 can be programmed on the fly, so that the computer is producing new center frequencies; and the tuning is much like the good old analog VFO. The "on the fly" programming is done using I^2C bus technologies (I^2C is a protocol for communicating with devices hooked up to a computer). USB to I^2C interface kits for use with SDR are being sold and are relatively inexpensive. One kit provides the appropriate control signals to a Si570 that might be incorporated on the main hardware board and another kit includes both the interface and the Si570 where the frequency generating hardware does not exist on the transceiver board. The first kit is in the $15 range and the second in the $40 range. The heart of these USB I^2C interface kits is an Atmel AVR Microcontroller IC that has been programmed with firmware to respond to the computer input and provide frequency control and other functions to the radio. These kits are available from SDR.kits, and information on them can be found at http://www.sdr-kits.net/USB/USB_Description.html#pricing. The kits are sold in the USA through KM5H, Tom Hoflich.

As a final word of caution regarding the Si570, the system using the chip may

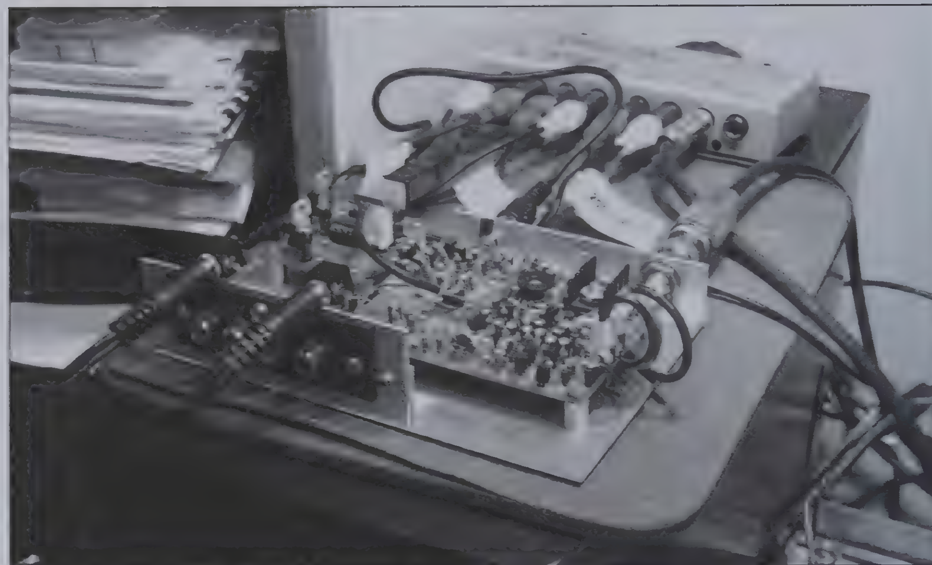


Figure 2—The modified V6.2RxTx in operation.

require some calibration before use. Although the chip itself is specified for 1.5 PPM in frequency accuracy, about 20 Hz for a 14 MHz LO, you may find that once the chip is part of a working LO subsystem the actual frequency and displayed frequency are quite different. Once again Bob, G8VOI has prepared a tutorial on how to put the Si570 exactly on frequency through a calibration of the AVR firmware. Thus once calibrated, the Si570 will be on frequency for any of the SDR software that might be used. See the following link for the Si570 calibration process,

http://home.ict.nl/~fredkrom/pe0fko/g8voi/PE0FKO%20SoftRock%20AVR%20Firmware%20User%20Guide%20Issue%201_1.pdf.

I recently used one of these Si570 kits to modify my V6.2 RxTx, which was initially a crystal LO kit. The Si570 and USB I^2C kit allowed me to run the V6.2RxTx on the entire 20M band, where it produces a signal in excess of 1 watt. Figure 2 shows what my setup looks like in operation. The SDR is sitting on top of the station PC and my Delta 44 sound card is behind it. The large PC board in the SDR is my V6.2 RxTx and the smaller board at the left is the Si570 and USB I^2C kit.

As an initial setup, I have been running the radio with an external solid state amp and typically see about 60 watts to the antenna. Many stateside and DX contacts have been made using this combination. However, now that I have the radio, software, desktop computer and sound card working in unison, I will soon be trying some QRP contacts. The ability to "manage" the QRM, bandwidth and gain settings is truly amazing! I would never have believed that my initial $50 investment could pay such big dividends.

SDR Software

Next I would like to cover the actual SDR software - the good news being it is free! I have loaded five different programs on my computer and these include Rocky 3.6, Power SDR V1.19 SR40, Power SDR-IQ V1.12.20, V1.12.23 and V1.19.3.15 (AKA V2.0).

Rocky 3.6 is an ideal program for those just starting out and gives a good account of itself for use with even the simplest SDR radios. There is much behind the scenes taking place with Rocky and it is a real credit to its creator Alex VE3NEA. I have found that Rocky works best for CW and BPSK. While it can receive LSB and USB it does not have the functionality to handle these modes in transmit. See http://www.dxatlas.com/Rocky/

Power SDR V1.19. SR40 — http://powersdr-sr40.sourceforge.net/ Guido PE1NNZ has created a "how to document" to install and set up this software and can be found at http://powersdr-sr40.svn.sourceforge.net/viewvc/powersdr-sr40/trunk/Documentation/PowerSDR-sr40_Setup.pdf

Christos SV1EA, using the open source FlexRadio Software has developed some very sophisticated software that

drives the Si570 Frequency Generator (as well other options such as a crystal LO) and will even work with the Flex 5000. The front panel display is very similar in appearance to the FLEX Power SDR panels. Christos has added some refinements that make automatic adjustments to the hardware such as image rejection. That said, his software works best with "supported sound cards." Unsupported cards will work but many of the problems that may be encountered can usually traced to the unsupported sound card. My EMU 0202 is not a supported card and I had problems with all of the functionality. Switching to the Delta 44 card solved those issues. The Power SDR-IQ Version V1.19.3.15 software can be downloaded at: http://code.google.com/p/powersdr-iq/downloads/list. This particular version has a slightly different background panel color and is really slick in its operation. I am currently using this version on my desktop SDR computer.

WinRad is yet another SDR program, but I have not used this resource for actual SDR Communications. I have loaded WinRad on my computer and have used it principally for Fred's, PEØFKO, Si570 Frequency Calibration Utility.

Sound Cards

Now to the sound cards. The sound cards clearly end up being the determinant between whether something is just barely operating or is something that operates really well. In setting up the Power SDR software, the selection of sound card is done in the Audio Tab. See Figure 3 which shows the Audio Tab and array of supported cards. Note the final entry in this list is "Unsupported Card," a choice that can lead to some real problems for a newcomer.

When making a choice there are several selections for supported cards that include PCI, Fire Wire, and USB type cards. These cards are typically devoted solely to the I/Q processing required by an SDR. Some supported cards also have functionality to also handle the typical audio functions such as speaker output and microphone input. Some arrangements require the use of two sound cards; one for I/Q and the other to handle the audio functions. There are two cards that are generally considered near the top of the ladder. The first is the M-Audio Delta 44 is a PCI card that comes with an outrigger junction

Figure 3—Sound card selection in the PowerSDR software.

box to handle four inputs and four outputs. Being a PCI card, it is primarily suitable for desktop computers. The second is the Edirol FA-66, which is a FireWire type card and can simultaneously handle I/Q and Audio as there are six inputs and six outputs. Having a FireWire interface, the Edirol card is suitable for a laptop computer, which seems ideal for SDR work as its portability couples well with the diminutive radio hardware. In the case of the Edirol FA-66, that card with a little shopping retails for around $300. Ouch! I have not priced the USB supported cards but mostly likely they are likely to be more expensive than a non-supported card. So that is a consideration. FlexRadio has a series of Knowledge Base documents on their website that covers how to set up these cards. Search for Delta 44 Quick Start Guide pdf and/or Edirol FA-66 Quick Start Guide pdf. In the case of the Delta 44, you must use an earlier driver to work with the Power SDR software. It is this version: DM5.10.00.5052v3.exe, which is available on the M-Audio website under the Windows XP SP 2 listings. Later versions will not work.

I can say with certainty that it is wise to use a supported card! I struggled with the unsupported card and many of the glitches I was experiencing simply went away when I switched to a supported card.

Some Final Thoughts

To digress for a short moment, I would like to reflect on the fact that ham radio is a wonderful hobby that frequently reinvents itself. SDR is an excellent example of that reinvention. For instance, in the early days of SSB there were two principal methods (although you may see references to four methods) of receiving and generating SSB signals. The first type known as the phasing method, is where RF and audio signals were created and split into signals 90 degrees out of phase. Depending on how these signals were recombined, the carrier signal was suppressed and either upper or lower sideband resulted. The phase shift networks that were used in these radios had to hold the phase shift error to a small value over a wide range of frequencies. That holding ability was driven in large measure by the stability of the components—we're talking drifting resistors and capacitors. It seems like those using the phasing method were subjected to making drift corrections on an ongoing basis. For that reason the phasing method soon gave way to the filter method, which did not have the touchy circuits and improvements in manufacturing produced high quality crystal filters with very steep skirts. The filter method was king of the hill for over 50 years, but that has been

changing with the advent of SDR! The phasing method is at the very heart of the SDR radios! Thus, the reinvention aspect lives on.

Further, I would like to add that QRP operations and SDR are a marvelous fit, like a hand in a glove. Typically QRP hardware is fairly simple in design and part count. That said, the no frills approach does have limitations driven entirely by the hardware. Now when you incorporate that same hardware into a Software Defined Radio, suddenly a whole "new world" of possibilities opens up. Once you have all the information and suitable supporting hardware in place, a $50 radio kit can literally can sound and perform like a $4000 radio. The short side of QRP SDR operations, for at least right now, is that the small QRP radio board has to be tied to some rather large peripheral hardware. However, I know that several individuals are working on projects to literally shrink the external hardware to something on par with the size of many QRP radios we see today. So portable operation with QRP and SDR is ever looming on the horizon. As they say—stay tuned!

In a nutshell, SDR has many wonderful attributes but does require something more than "plug & pray." There are some issues that need to be understood. You also have to learn a slightly different way of operating. There are no knobs to twirl or adjust. Most of the adjustments are made with the mouse. So eye-hand coordination suddenly goes to being a top skill. You may also have to learn some computer skills beyond opening emails. But it is like riding a bicycle—once you learn you don't forget how. And, the rewards are tremendous! I cannot over-emphasize the fact that with relatively inexpensive hardware it is possible to have comparable performance that currently only exists in radios costing thousands of dollars.

—73, Pete N6QW

Homebrew Contest Recap from FDIM

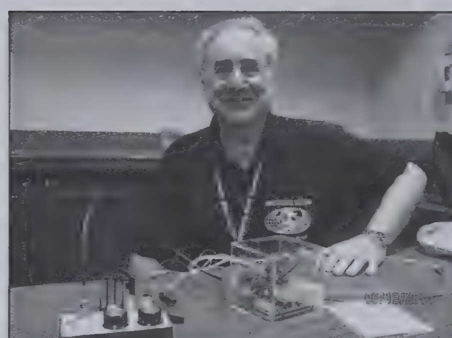
Jay Bromley—W5JAY jayw5jay@cox.net

This year's Homebrew Contest was another interesting and fun one, thanks to Terry Fletcher, WAØITP, who headed up the building contest for the second year in a row. This year's number of entries was about the same as years past, but the show-n-tells were up from past years.

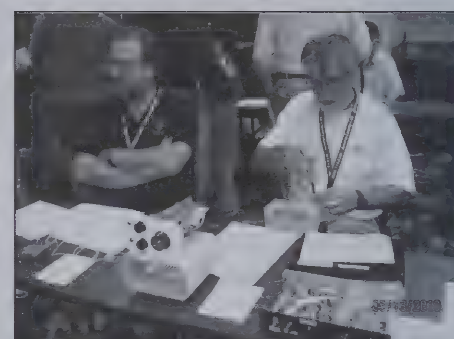
David Cripe, NMØS, was showing off his minimalist rig with paddle keyer combo. You might remember David's NS40 transmitter from the 4SQRP group. Jim Kortge, K8IQY, had a soon to be 4SQRP project, The Magic Box. The Magic Box is a solid state electronic transmit/receive switch designed by Jim. Other favorites of the show-n-tell were from Fred Saas, WA8PGE, with his Softrock receiver, transceiver, Firefly SDR combos and Paul Daulton, K5WMS, lowfer loading coil and QRSS beacon setup. None of these entered the contest, but were a big hit with the attendees.

Like in years past, some thought they didn't have a chance of winning, but decided to give it a go anyway. Preston Douglas, WJ2V, was one of those who started not to bring his SDR creation for fear TSA thinking it was some sort of bomb, but he changed his mind and had it shipped to the motel anyway. Preston's SDR SoftRock 6.3 transceiver with controller was good enough to pull off a win in the category for Transceivers, Transmitters, Receivers, and Power Supplies.

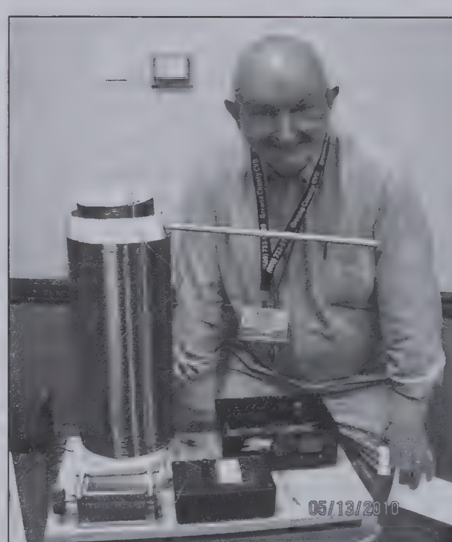
Richard Meiss, WB9LPU, again brought in some fantastic morse key cre-



Preston Douglas, WJ2V, and his SDR rig that won in the category for Transceivers, Transmitters, Receivers, and Power Supplies.

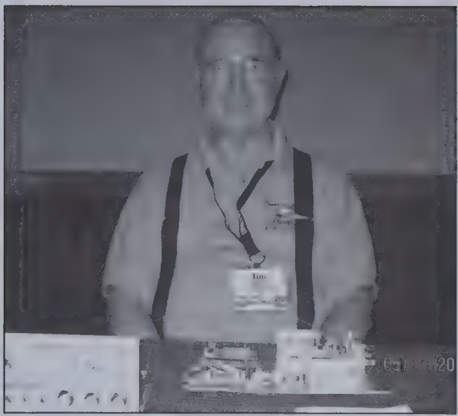


David Cripe, NMØS, and his minimalist setup, and Harold Smith, KE6TI, shown working on his winning 72 Challenge 80m rig.

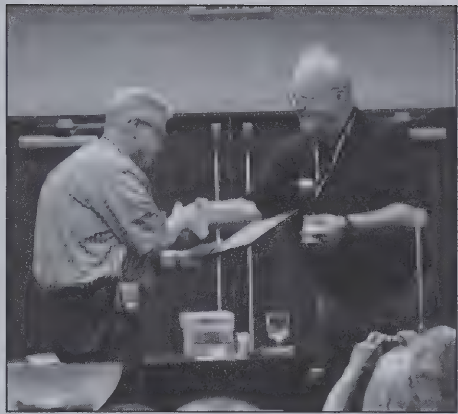


Paul Daulton, K5WMS, with his lowfer setup for show-n-tell.

Fred Saas, WA8PGE, and his super nice SoftRock and Firefly SDR rigs.

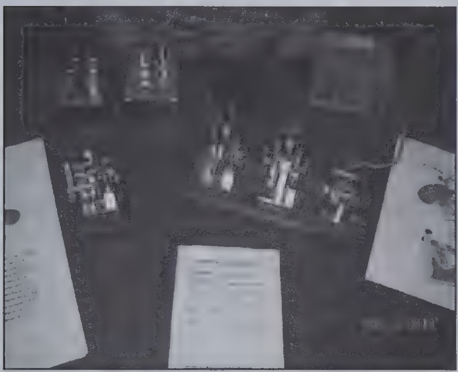


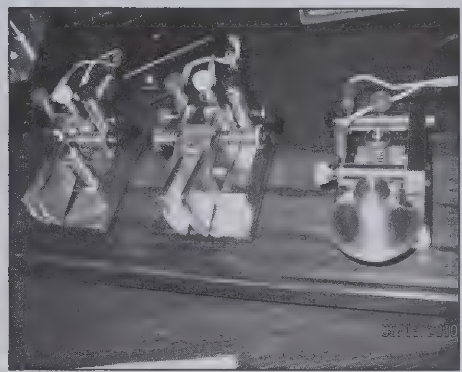
Jim Kortge, K8IQY, and soon to be 4SQRP project, The Magic Box.



Terry Fletcher, WAØITP, giving out an award to Richard Meiss.

Terry Fletcher, WAØITP, giving out an award to Preston Douglas.





Richard Meiss, WB9LPU, with his beautiful keys! Richard won Best of Show and also Station Accessories.

ations. Rich calls this group his Pico Bug family of Paddles. If you haven't seen Rich's keys you owe it to yourself to see them next year. Watching him set them up and then getting to play with them is a treat. Like with so many of the entries, I have to wonder what makes their minds tick to come up with such out of this world creations. Rich pulled off Best of Show category win with his keys. He also won in the category of Station Accessories.

Harold Smith, KE6TI, won the All Scratch Built category with his 30m transceiver. The 30 rig was in a very nice extruded cabinet. I love the big knobs you can grab with no problem, but the rig is not so big you couldn't take it to the field. Harold also took top honors in the 72 Part Challenge contest with his very nice looking 80m CW rig.

The contest started on Thursday night, however Friday night was the final judging. Some guys couldn't make if for Friday night's judging, which was a shame as it seemed to be the heaviest night attendance wise. Out of 200 plus attending Vendor night we had right at 50 attendees taking the time out of vendor night and the Elecraft forum to vote on their favorite homebrew equipment. A big thank you for all that took the time to vote on your favorite entry!

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Extreme QRP on 14,064 ft. Humboldt Peak

Guy Hamblen—N7UN N7un.guy@gmail.com

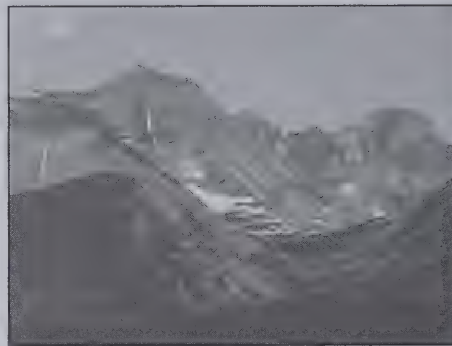
N7UN and wGØAT take us on another Colorado "Ham-14er" NØB summit activation and adventure featuring the Sherpa goats, Rooster and Peanut.

History of Colo-14er August Event

Climbing any of Colorado's 54 summits over 14,000' has been a popular local challenge for thousands of the adventurous in Colorado. Several years ago, a group of Colorado hams started an annual event of activating a 14-er summit, operating primarily VHF with FM with mountaintop to mountaintop QSOs. The goal was ham radio fun and adventure [1].

Any climb above 10,000' is difficult to say the least and potentially life-threatening as the weather can become dangerous in minutes. These Colorado mountains can create their own weather but generally the time of year determines the level of risk with winter mountain assaults obviously most dangerous. However, in early August weather conditions are generally most favorable for a sunny, relatively warm, summit opportunity. And what a better "tower" could a HF or VHFer ask for? Most of the 14er mountains have a HAAT (Height Above Average Terrain) of 4,000 ft or more depending on the azimuth direction, perfect for low power QRP 2m, 6m, or 70cm VHF portable operations and ideal for HF!

A local group of hams started the "Colorado 14er" special event with the goal to activate a favorite summit and make as many QSOs with other activated summits. In 2008, Guy/N7UN and Steve/wGØAT took the challenge a step further by trying to contact an out-of-state activation of a California 14er (Mt. Whitney, 14,495') where Brian/N6IZ had summited in order to set a "first" for this event. You can read about our 2008 HF/VHF QRP adventure from the summit of Mt. Uncompaghre (14,300') at our NØB blogsite [2] and follow the links to view Steve's famous videos with our sherpa Goats, Peanut and Rooster as we climb thru the clouds to activate Mt. Uncompaghre. Or read our story in the Spring 2009 issue of *QRP Quarterly.* We first used the special event callsign of NØB for that event.



14,064' Humboldt Peak, the site of our summit QRP activity.

Why goats you may ask? Pack goats are the perfect trail companion in that they don't bark, bite or chase! They have lowest impact on the environment of any of the other pack animals. They can carry about 25-30% of their body weight just like a human. They can hike places a horse, mule or even a llama may have difficulty and are right at home in the Rocky Mountains. Best of all, their attitude is amazingly friendly, curious and positive, once you're accepted into the "herd." They're non-aggressive and actually like people if raised around people. Steve's "boys" think he's the two-legged alpha goat and hence follow him anywhere!

Steve's pack goats, Rooster and Peanut, are wethered male dairy goat rejects. The term "wether" means they've been neutered. Thus they don't go through a male rutting season and all the attendant behaviors in order to attract a female goat. Wethers are much more docile than the active male goats. Goat dairies tend to typically get rid of the male goats for obvious reasons since it only takes a few males to keep the production line going. Steve's often heard saying he's rescued Rooster and Peanut from the butcher but the truth is they've rescued him from the TV remote by becoming his best ever trail buddies!

So, on our drive home from Uncompaghre, we were already dreaming of the 2009 event. We could use NØB again and perhaps "market" the event to maximize our QSO rate for HF and VHF from the summit, hopefully recruit some other California hams to climb any of the 15 California 14ers. Could we get two California 14ers activated for a 3-way HF QSO? Or could our adventures entice other hams to activate the highest point in their state? After all, the western Kansas hams "trek into thick air" annually for this event with the "dangerous" climb up Mt. Sunflower (4,400)! This could become a really fun national event with many great stories!

Preparation, Planning, and 2009 Goals

For the 2009 event, we wanted to experiment with a portable APRS system to provide the ham community and family/friends near realtime location information on our climb progress up Humboldt Peak. And this time, portable vertical antennas for HF and a backpackable 2m VHF antenna were definitely on our list. And perhaps another "prep" day by camping at altitude (above 10,000') for acclimatization, especially for the author who is arriving from almost sea-level!

Steve/wGØAT had spent several weeks reviewing and selecting a half-dozen candidate 14-ers for 2009, then in late July, visited the targeted 14er, Humboldt Peak (14,064') for our August trip. He wanted to make sure the road to the trailhead was accessible and is goat-passable for both Rooster and Peanut who will be riding in the pickup bed. Overnight camping sites and water availability were the critical requirements as well as a "goat-safe" trail to the summit. Both of Steve's goats are resourceful climbers but we didn't want to needlessly put them in harm's way.

And like in 2008, we wanted to try for a record-setting 3-way HF QRP contact from the summit of a Colo-14er to an out-of-state 14er. Brian/N6IZ who was on Mt. Whitney in 2008 was planning to climb Mt. Shasta (14,179') in northern California and Mark/AF6AZ on Mt Langley (14,026') in southern California was simultaneously planning to summit Langley. Could we set a new HF record?

Day 1 (Thursday, Aug.6th)

I left Newark, NJ midday intending to arrive in Denver early evening with a leisurely 60-minute drive south to wGØAT's ranch just north of Colorado Springs. But, as my aircraft entered into a

holding pattern in western Kansas, some 100 miles east of Denver, I saw why. The sky over Denver and the airport was literally obsidian black. Just then the pilot informed us in his best I-gotta-stay-calm Captain's voice, "Well, ladies and gentlemen, air traffic control has delayed us as some severe weather passes thru the Denver area." No kidding, I was thinking to myself! This thunderstorm was huge!

Well, after 45 minutes, our flight was now diverted to 100 miles south to Colorado Springs where we will take on fuel and more importantly, wait out the storm. Ok….I'm all for that plan! So two hours later, the plane arrives in Denver and I arrive at Steve's 4 hours later than planned. I hope this isn't an omen for this adventure!

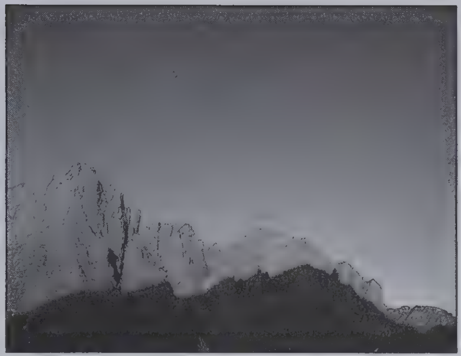
Day 2 (Friday, Aug 7th)

I intended to use the Byonics [3] Micro-Trak 8000 FA ARPS system, a small BatterySpace lithium ion battery pack, a GPS-2 receiver, and a small 19" whip antenna for location reporting. For the 3 hour ride to the Mt. Humboldt access road, I had the APRS unit setup on Steve's pickup so folks could monitor our trip progress. Fortunately, Colorado has a number of APRS Digi-repeaters on nearby mountain peaks so we had very good APRS coverage until we got to the Humboldt Peak access road.

The access road is almost another story! It was 10 miles of unbelievable torture. We could only travel about 5 miles an hour in the best sections. I've been on some rough roads but this was barely a road! It took us about two hours to get to the Mt. Humboldt trailhead and camping area.

The goats were amazing travelers although I'm sure they were questioning where the "Old Goats" were taking them. There was a fairly large group of folks at the trailhead campground including a 20-person plus "trail maintenance" crew. And within minutes, they spotted the goats and now Steve was on "show-and-tell" duty. I call it his "Petting Zoo" because people are so curious and are attracted to the goats like magnets.

This location was amazingly beautiful. The access road weaves up a canyon of granite and basalt cliffs on either side as we climbed to the trailhead campground. We were in somewhat of a box canyon



View of 14,197' Crestone Needle from our upper base camp.

N7UN on Day 1 lunch break with a view of the "Stairway to Heaven" slope.

with a number of 14ers circling around us. Absolutely spectacular! You have to watch the videos to believe the beauty of this location.

Before long we had camp setup and were settling in to dinner and a warm campfire. Night falls early in this canyon area although the alpenglow in the mountain tops were exquisite. And at 11,000' you get surprisingly tired very quickly, at least that was true for this sea-level landlubber!

Day 3 (Saturday, Aug 8th)

The goal for Day 3 was to move up to a higher (11,800') base camp, nearly at the base of a most strenuous 1,200' climb of a 35-deg pitched slope. The trail criss-crossed this slope, keeping the trail at a reasonable grade but nevertheless quite demanding. We counted 9 switchbacks to get to the ridge top. I nicknamed this section the "Stairway to Heaven."

It was also windy. Persistently windy! We could hear the wind in the tree tops higher up the mountain. This constant wind will become the central theme of our climb and Humboldt Peak QRP activation. We never really escape this wind, day or night. But at this point, we were hoping it would die down, especially on Day 4, our summit climb.

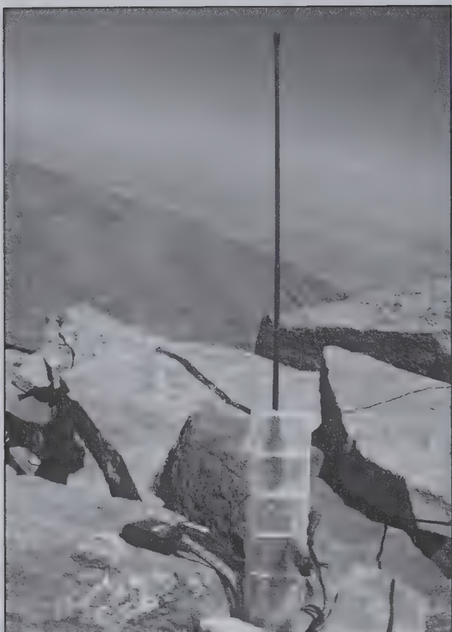
We awake early to a beautiful star-filled night sky. But daylight is soon upon us and we prepare for the base camp move higher up on the mountain. Although we know that afternoon thunderstorms are "the norm" and are always to be expected this time of the year in the Rocky Mountains. We wanted to move our camp to a higher camp area around a glacial lake but we find that area was too exposed and without any real sheltered areas to escape the incessant wind. We drop our packs, have lunch with a very picturesque view of a 14er called Pinnacle Rock, then decide to take a "day hike" up the "Stairway to Heaven" to the summit ridge. It would be a good "acclimatization" climb to 13,000' we theorize. So over the next hour, we plod our way to the ridgetop. Wow! We now get some perspective of all the mountains around us with views 50 miles in all directions once we get out of the box canyon area. But yet the wind was still incessant with gusts at 30+ mph. I activate the APRS system and we later found out that we were making it through some distant Digi's.

We returned back to our packs and decided to move into an area of trees hoping to get some shelter from the wind. We set up camp, had an early dinner, and were in our sleeping bags by nightfall. Maybe the wind would die down overnight and be gone when the 4 a.m. alarm goes off.

Day 4 (Sunday, Aug 9th)

Do you know how early 4 am is? Especially when the temperature is in the low 40s, your sleeping bag is cozy warm, and the wind is STILL blowing! It takes a herculean resolve to get dressed, boil water for coffee, eat breakfast, get the goats ready, all in the dark! The full moon however provides ample light for the trail hike and the cloudless night sky picks up our spirits as there are no signs of ominous weather. Nevertheless, it is really hard to get going.

But we are soon on the moonlit trail with sunrise in another hour or so. Like fireflys, we could see the peakaboo headlamps of other climbing teams across the canyon as they slowly traversed their way up the trails to Crestone Peak and Crestone Needle, a much more technical climb and



The N7UN portable Byonics APRS system for location tracking.

Our summit site. Notice the wind bending the vertical!

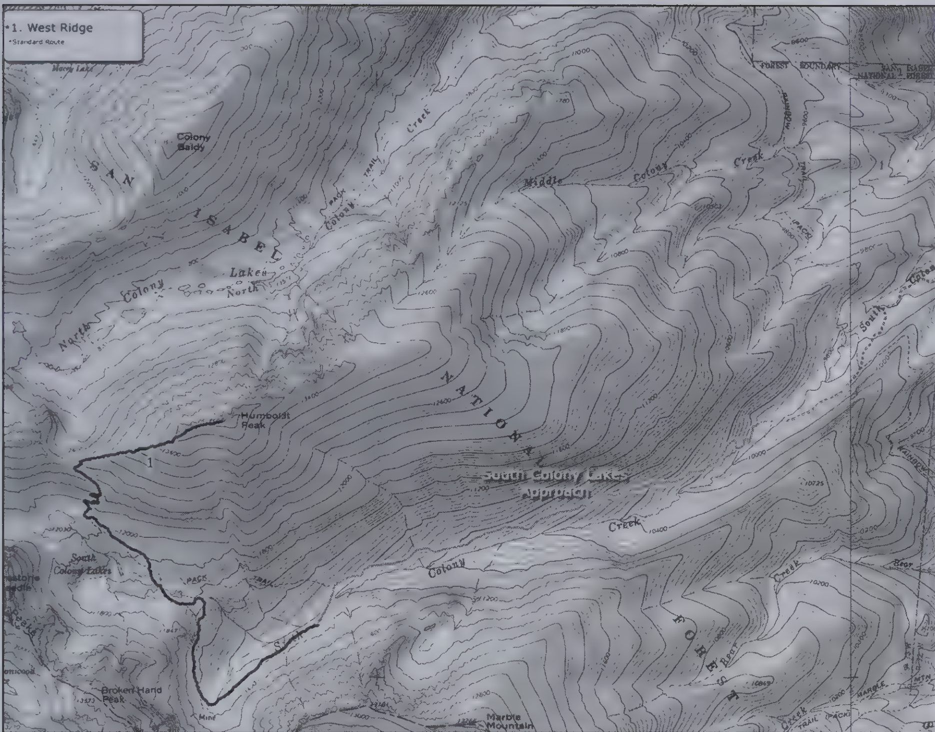
wGØAT, Peanut the goat, and N7UN prepare for the pile ups!

certainly less goat friendly! Although the goats certainly could have made that climb but the Old Goat's technical skills weren't up for a hard core test this trip nor were we equipped for any of the high exposure technical routes those mountains demand.

We make it up the "Stairway to Heaven" in good time to the 13,000' Humboldt ridgetop and I activate the APRS beacon so others can see our location via the internet. As we head up the ridge, we can see the sun shadow of Humboldt behind us. Wow! Are we going there, we question ourselves. And the wind continues to blow, especially now that we are not sheltered but are on the ridgeline to the summit.

What we didn't count on was coming up! Up until now the trail was relatively easy, well defined, and with a minimum of climbing "challenges." At about 13,300' we encountered a recent rockfall where a significant amount of the mountain gave away, covering up the trail and leaving refrigerator-sized granite blocks. The trail was marked by small rock cairns about every 100 meters piled on top of the big stone blocks. In many places the Old Goats had to climb up hand-over-hand and Rooster and Peanut had to find their own negotiable path. It's uncanny though, how well their instincts and intelligence enable them to pick paths that we wished we had taken! The goats are herd animals and their driving need (i.e., survival instinct) is to stay with "the herd" so they will always find a way to stay with Steve and me. For them to fall behind would be akin to tempting death by being attacked by a predator mountain lion. Thus, survival and safety lay in staying with the herd at all costs. Although, there were a couple of sections where we had to take their packs off so they could negotiate more challenging climbing areas.

We made it to the top about 3 hours after leaving base camp. Not too bad for a bunch of Old Goats. But what we didn't count on was the 40+ mph winds. How were we going to set up the HF antennas in this wind? Fortunately, some other enterprising climbers had constructed a rock shelter with 4' high walls... just enough to get us out of the ceaseless and gusting wind. But the goats were already challenging us for the space! That's alright, we can share! It was fun, to say the least, in raising up the modified BuddiPole Vertical in the gusty winds. But soon we were on the air and 20m was hopping hot. A quick NØB



Topographical map of Humboldt Peak with our hiking route in blue.

Sherpas Peanut and Rooster, with Steve/wGØAT and the false summit of Humboldt in background.

CW call brought a mini-pileup and we were off and running. Steve was knocking out the VHF contacts with other 14er summits and even picked up an aeronautical mobile station who was participating in the event. Other than the constant wind, the weather was cooperative with temps in the mid-40s, sunny, and no black clouds forming to our west. Rooster, Steve's 225-lb packgoat can be bit clumsy and irreverent of one's radio equipment at times. To prevent Guy's K2 from being goat-stomped and the coax from being chewed through meant a diligent goat watch was in effect. Fortunately our faithful sherpa friends were far too tired to do much more than stand around and doze while chewing their cuds.

NØB was unable to contact either Brian/N6IZ or Mark/AF6AZ during our 3-hour stay on Humboldt Peak. Mt. Shasta is a technical climb because of year-around snow, late-summer rockfall, and glaciers. Brian/N6IZ didn't make it to the top because of the dangerous rockfall and some painful boot blisters but was on the air at the 11,000' level—we just couldn't hear him. Thanks to Budd/W3FF of Redding, CA (20 miles from Shasta) for acting as our relay in passing messages to Brian. And Mark/AF6AZ had some last minute logistics problems so we also missed our QSO with him. Maybe next year! Our best DX was Kurt/HB9AFI who gave us a solid 559 on 20m CW and this was a polar path for the QSO! NØB had over 60 HF QSOs and 20 VHF QSOs. We regrettably never made contact with the Mt. Sunflower gang in western Kansas who courageously activated the highest mountain in Kansas (4,039') and recently produced a video of their ascent titled "Into Thick Air" [4].

After 3+ hours at 14,040' we were tired including the goats. Always a fun part of an operation like this is wearing our "ham radio ambassador hat" and explaining to other climbers what we were doing with ham radio and the fun discussions about the goats. Most people have not been around goats and were very curious and fascinated that we had used them for light pack duty in our climb. But it was time to climb down, fortunately much easier because gravity is working with you!

The return trip to base camp was fast and we packed up camp for the 2 mile hike out to the trailhead and the 4 hour drive back to Monument, CO. We were tired but excited. The goats, hardly impressed with this adventure, quickly fell asleep once we were back on SMOOTH road again. We had a great time, made a lot of good QSOs, talked and explained ham radio to a lot of people and gained a lot of valuable experience on another summit activation of a 14er. Certainly this was no ordinary QRP field outing which makes the story even more meaningful, especially for a couple of 60+ "Old Goats." But with careful planning, a well thought out aerobic training program starting months before, with a few acclimatization days, and a desire to really push a QRP field activation to an extreme event, we were successful. Is this for everyone... definitely not, but it can certainly add a terrific "story" to your arsenal of tall-tales and ham radio adventures! Now what are we going to do for 2010?

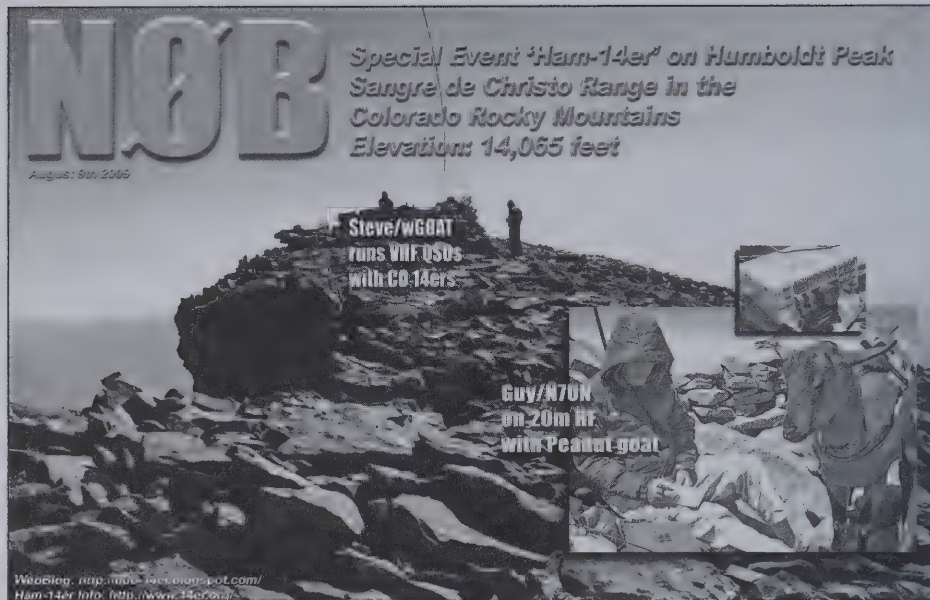
Day 5 Return to Reality

I had an early flight out of Denver and back on the job the next morning, but now with another great story and adventure under the belt. Clearly this is a fun event! Steve and I discussed our interest in expanding APRS tracking capability perhaps even with a portable Digipeater setup on a high ridge to capture our activity in the valleys. And certainly we want to explore the two-way packet messaging capabilities of the APRS protocol.

But more importantly we really want to encourage other "adventurous" teams to activate the highest point in their state. This could turn into a fun national event as

we had several teams in California activate mountain tops for this event. And as SOTA (Summits on the Air) [5] begins to proliferate in the USA this could be another special event for those participants.

So start making your plans for the first weekend in August 2010 and look for NØB to be active on another Colorado 14er with the Old Goats and the sherpas, Rooster and Peanut!



Our NØB qsl card for this special event.

References

1. See http://www.14er.org/ for more information about the Colorado ham 14er events. [*And see the note below —Ed.*]

2. See http://n0b-14er.blogspot.com/ for a chronology of both Mt. Uncomphagre (2008) and Humboldt Peak (2009) and the YouTube videos for each activation.

3. See http://www.byonics.com/microtrak/ for more information about these APRS products.

4. See http://www.bettingers.org/air/index.htm for the conquest of Mt. Sunflower, aka "Mt. Doom."

5. See http://www.sota.org.uk/ for more SOTA information.

About the Authors

Guy Hamblen, N7UN, has been a ham since 1963 where the deep hum of big power supplies and the dazzling meter lights of his first Elmer in Idaho captured his imagination as a teenager. Hiking, mountain climbing and the outdoors has always been a part of his life. Guy was first licensed as K7YYK, then AA7QZ, then finally N7UN. After relocating to New Jersey with his job at the UPS Information Technology center, he began hiking in the Catskills and Adirondacks of the Northeast, always taking his trusty Elecraft K1 transceiver to have some QRP fun in the field. It's always fun when you get to answer the inevitable question: "You're doing what?" That in itself is the reward for QRP in the field.

Steve Galchutt, wGØAT, adventure into ham radio all started back in the early '50s with a one transistor crystal set he got for my 9th birthday. Steve roamed the neighborhood clipping on to fences, down spouts and anything metal to see what he could pull in on that tiny earphone. He was enamored with radio waves. QRP has been his main focus over the years, along with building his own gear and operating outdoors. He has built numerous QRP rigs from scratch and kits including several Elecrafts (K2, K1 and KX1), KD1JV's little ATS series of SMD designs for backpack/trail use. The "magic that happens" when, out on the trail, miles from nowhere, you are able to make contact using just a simple wire in a tree and a tiny CW rig you've built yourself. That is the excitement for me! It's that same thrill you got from having your very "First QSO" all over again. Several years ago he got interested in pack goats, and now Rooster and Peanut share his load when they go backpacking or for a QRP/goat hike.

The "Original" Colorado Fourteeners QRP Expeditions

The present Colorado 14er Event is the descendent of an earlier series of operations organized by the Arapahoe Radio Club of Littleton, CO. Although my personal recollection is incomplete, I believe the first event was held in August 1987, with attempts on at least four summits—one ham drove up Mt. Evans and operated on 20M CW, another did a technical climb on Mt. Wilson carrying a 2M HT. One more got partway up Long's Peak, while I attempted to climb Mt. Democrat. High winds and inexperience ended my effort early, but I was able to drive to Mt. Evans and make several 2M FM QSOs from that summit in the afternoon.

In the following years, I operated twice from Mt. Sherman (14,036'), once from Gray's Peak (14,270'), plus another unsuccessful attempt on Mt. Democrat (14,148')—didn't reach the summit in time, but operated from well above 13,000 ft. The most memorable was one of the Mt. Sherman operations. My oldest son, Alex—a 15-year-old at the time—was my climbing partner. With perfect weather, we were on the summit for two hours, allowing time for many 20M CW QSOs. While I was operating, Alex rebuilt one of the rock windbreaks and helped explain what I was doing to other climbers who arrived at the summit.

Those early organized Fourteener events faded away after several years, but hams kept climbing the mountains and operating HF and VHF—eventually becoming re-organized as today's www.14er.org group.

Some of you will remember I designed a QRP transceiver that was published in *QST* in 1990-1991 and made into a kit by A&A Engineering. The entire reason for its development was to use as my QRP rig on these Colorado Fourteener climbs!

—72/73, Gary Breed, K9AY

Tim Stabler—WB9NLZ wb9nlz@yahoo.com

First of all, I must tell everyone that the XYL and I are finally in our new home after 15 months of "construction." It did take a long time and with the original builder going bankrupt, the whole process took a lot longer than expected. The "second in charge" at the builder's did take over the build for us so the house was done very well and we are extremely pleased.

And, although I did not mention it in the last column, I did get my knee totally replaced in November. The nurse in charge of therapy at the hospital said I was a "showoff" doing the exercises so well. That was because I did leg exercises at home before surgery. I got home 2 days after surgery after doing the up-and-down steps in therapy and was driving two days later (so I could go to post-surgery therapy —6 weeks). I am doing very well now and continue therapy exercises at home with my 10 lb ankle weight.

Members of the Minnesota QRP Society.

Minnesota QRP Society

First of all, I must apologize to this group for not including them in my last column on QRP clubs. Dave Kent, WØRU, sent me club information probably as soon as I originally asked for it in December, and I must have only gone back to January 1, for email responses.

The Society meets the first Saturday of every month at the Minnetonka Community Center in Minnetonka, MN, at 1:30 PM. Officers for 2010 are Steve Ulrich, NWØC, President; Ron Dodge, KØTC, Vice-President and Dave Kent, WØRU, Secretary-Treasurer.

Recent club projects have included building the Norcal 2N22/XX transceiver and the AAØZZ keyer from the Four States QRP Group. The club is active in FYBO and Field Day activities.

Further information can be obtained at their website, www.mnqrp.org. If you wish to subscribe to their email, go to members-subscribe@mnqrp.org.

San Antonio QRPadillos Radio Group (SAQRG)

I received information from Michael Goins, K5WMG, that a new QRP group was forming in San Antonio. The group is a loose-knit group of ham radio operators who meet regularly to discuss low-power (qrp) radio, antennas, field operations, DXing, contests, coven ants and just for fun and to be sociable.

Meeting time and location will be announced soon and membership is open to anyone, anywhere, who has a love of low power radio and understands what amateur radio is all about. Living in Texas is not a requirement even if you wish you could.

Personal assaults, flaming, and just being ornery for no reason will not be tolerated. Remember, SAQRG is a social group, so everything should be kept sociable. I do not know of a website at this time, but their yahoo group is at: http://groups.yahoo.com/group/QRPadillos/. I found it, and can announce I am 'dillo #17.

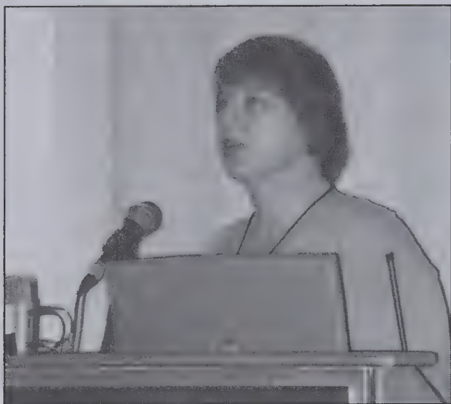
Masscon

In March, I drove to Massachusetts to attend the Massachusetts QRP Convention. I drove in order to see family in New York. This event was sponsored by Buddipole Antennas and PART, the Police Amateur Radio Team of Westford, MA. I know there was a write-up in the last issue, but thought I would add a little for those that might be interested in attending if and when the event is held again. I might add that a couple of attendees asked me why a "9" call was there. I answered that my original call was WA1RJL. That took care of everything.

Registration and an informal get-together was held Friday night. When doing your registration, you received your name and call badge plus a CD of all slides being used for the talks in both Adobe or Power Point format. If you would like a copy of the disc, go to the website www.masscon.org and download it. I wanted to look at the disc again recently and managed to misplace it (in my "new" home), so downloaded it. You can then print out the slides to look at later, if you wish. One more comment about the disc is that when you go to the Power Point version of each talk, in the upper left-hand corner, you can use your pointer to go from "slides" to "outline" to see speaker's notes on each slide, although all speakers did not enclose notes. You can clip these notes and then print them out in Word. I have found this CD to be very interesting to go over the talks again. Everyone present liked this CD idea.

On Saturday after the welcome, Scott Andersen, NE1RD, introduced the first talk on "QRP other bands, other modes and large antennas" which was given by Allison Parent, KB1GMX. She has built most of her equipment and likes 40M as the band is usually open to anywhere. She is now into satellite work (with a hand held Yagi) and told us QRP people use their homebrew equipment. She encouraged everyone to get into low power VHF and UHF work, especially with the upcoming (hopefully) sun spot cycle. Her major comment was that if you get it on the air and make "noise," by all means do it!

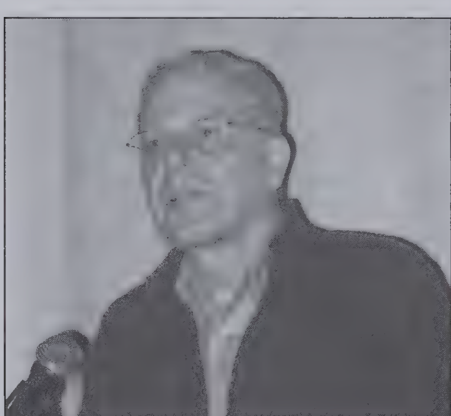
The next talk, "RF Filters: From Design to Construction and Testing" was



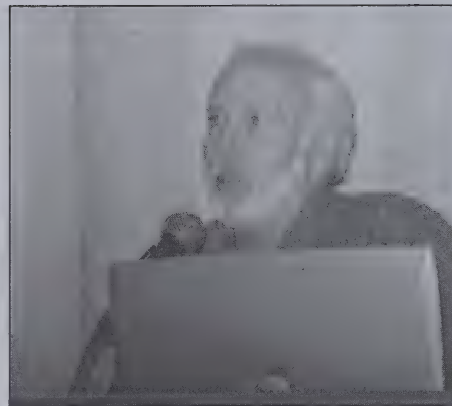
Alllison Parent, KB1GMX, spoke about QRP on other bands.

actually in two parts. In the first part of the talk, Dave Siegrist, NT1U, talked on the theory and design of RF filters. There are trade-offs in what type filter is being used. Not all frequencies will pass through a filter without some delay. The rate of change in a filter curve may lead to ringing. Filter types, such as the Butterworth, Chebyshev and Bessel, were discussed including the passbands and roll off of each. Normalized filters and filter order were discussed.

The second part of the talk was by Bruce Bedford, N1RX. He got into going from filter design to construction and testing. The first thing was to go over the latest FCC regulations on the mean power allowed for spurious radiation. In building a filter, theoretical calculated values may not be practical. Elsie filter design software can be configured to provide a design using capacitors in 5% value intervals. Various filter types based on components were introduced. Active and passive filters were discussed. A toroids program by Dieter Gentzow, W8DIZ, was talked about



Here is Nobel Laureate Joe Taylor, K1JT, speaking on WSPR.



Dave Benson, K1SWL, talked about his new AM transceiver.

in which the inductance desired and the turns count is calculated (http://toroids.info).

After a break, the morning talks continued with Michael Rainey, AA1TJ, speaking on "Hot Rodding." He started off by speaking about radios advertised in the late 1950s by Western Radio using the 3A5 tube. The radios did work well. In 1959, *QST* published a transistor converter for the 3A5. Eventually, a pedal powered portable radio was available. Michael has a website, www.aa1tj.com, which is very interesting for further comments about these earlier radios.

The final morning talk was given by Chuck Kitchin, N1TEV, who spoke on "Updating Classic Regenerative and Super Regenerative Circuits." He outlined basics about the two types of circuits and their tradeoffs. Chuck spoke of important design considerations for regen circuits and preserving coil "Q." He showed pictures of regenerative radios available now as well as circuits he has recently published.

The "Midnight Loop" presented by George Heron, N2ABP and Joe Everhart, N2CX.

Going to the Masscon CD, looking under "presentations" and finding N1TEV, the last two slides have a lot of published information on regenerative circuits.

After lunch, the first afternoon talk was by Dave Benson, K1SWL. Dave started his talk, "Something Old, Something New-A Medley of Ideas," showing slides of his new home which he built. It did take him 5 years, during which time he did not spend much time on amateur radio. With the house done, radio returned and Dave got thinking about AM. After looking at several past units, he set his goal for a AM transceiver. After trying some ideas, a final kit version was developed now available (http://www.smallwonderlabs.com). Dave then got into ideas for a SSB version of his Warbler with more power, QRSS (please send *really* slow) and WSPR.

The next talk, "The Midnight Loop-Theory and Practice of an Experimental Small Transmitting Loop," was given by George Heron, N2APB, and Joe Everhart, N2CX. They wanted to design a better type of loop antenna to couple with SDR radios. By increasing the surface area, they could decrease the losses. All materials were obtained from Lowe's and similar stores. The loop looks like a tuned circuit where the inductor is a large loop with a circumference of about 1/10 wavelength. The tuning capacitor was critical. But when compared with the MFJ loop, they felt theirs was about 20% better. A Micro 908 Antenna Analyset (www.amqrp.org) was used for testing.

The final talk was given by Joe Taylor, K1JT, on "WSPRing Around the World." When getting into something like this, one has to look at the lowest feasible signal levels as well as digital basics. Joe has a web page on this topic, http://physics.princeton.edu/pulsar/K1JT/index.html. One needs a SSB transceiver and a computer with a soundcard. Joe feels that JT65 is probably better than WSPR. Fraction of a second bursts 10 dB below audible threshold can be decoded. Users with internet access can watch results in real time ands see contacts being made world-wide.

That evening, there was a dinner. After dinner, we heard a talk by Stephan Galchutt, WGØAT. He hikes the nearby Rockies with his two pack goats, Rooster and Peanut. They carry his radio gear and other supplies needed for the hike. Steve has placed video cameras on the goats to

get a view many of us will never see (like looking over a thousand foot drop from a mountainside). He told us how he became the "alpha" goat after being butted by Rooster. His slides basically gave us a very enjoyable travelogue of the part of the Rockies where he lives.

Ozarkcon

Three weeks after Masscon, I drove to Branson, MO, for the 2010 Ozarkcon. This event is sponsored by the Four States QRP Club and the hotel is very accommodating offering five additional nights at the "meeting rate."

Registration started Friday afternoon. Prior to the dinner Friday evening, everyone was invited to go outside of the hotel where a group picture was taken. Orders were taken and enlargements were delivered later that evening. Right after dinner, Ingrid Alberts of the White River Historical Society gave a talk on how Branson was settled. With the size and steepness of hills, there were really no settlers until they came in by river.

After the talk was over, the vendor fair and swap meet opened. The hands-on building workshop was held and run by Dar Piatt,W9HZC, and Darrel Swenson, KØAWB. The kit that was constructed was the EZ Keyer designed by Craig Johnson, AAØZZ (this kit is being sold by the Four States Club). At the same time, the Dummy Load QSO party (KØN at 7040 KHz) started as well as the wacky key contest opened for entrants. Both of these events also ran all day Saturday. The evening ended with participants getting together with their guitars, bass, or whatever for the evening music jam.

The next day at the registration desk, greeters from the Chamber of Commerce were available for spouses and guests wishing to go shopping, museums, shows, etc. At the start of the meeting itself, Terry Fletcher, WAØITP, and Ron Potter, AG1P, introduced Raeanne Presley, mayor of Branson, who welcomed everyone to Branson and spoke of some of the Town's upcoming events, including the Christmas lighting starting November 1.

The first speaker was Paul Dutton, K5WMS, who spoke on "Low Frequency Beacons and Weak Signal Reception." He got into Part 15 of the FCC and what it would allow. QRSS is the common mode here with dot being 30 seconds long and

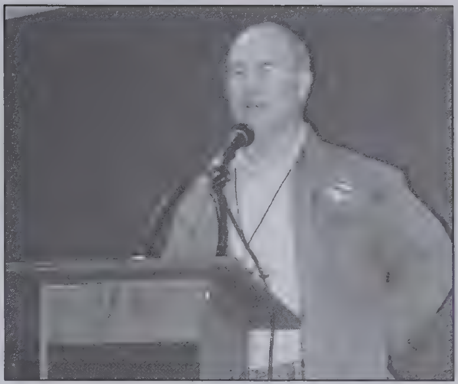
Craig Johnson, AAØZZ, talks to workshop builders about his EZ Keyer.

dashes being 90 seconds long. Using Argo software (www.sdrham.com/argo/index.html) , the soundcard is calibrated to WWV. Lowfer is actually the inverse of sunspots. Although not much is published on this topic, the best site for lowfer articles is http://www.nutstreet.net/k0lr/. Further information can be found at www.w3eee.com and www.w5jgv.com.

The next speaker, Dave Gauding, NFØR, spoke on "How About Some /P Antennas." Dave got into many ideas for portable antennas as he had moved to one of those places where external antennas are frowned upon. He tried aluminum tubing with a long screwdriver for a ground rod. He showed us how to use kite struts to put together antennas for 20M and 40M. 1/8 wave ribbon radials were used. His last antenna was a loop antenna made with the rim of a bicycle wheel. Dave is known for his work on the St. Louis Vertical antenna, so his various ideas for portable antennas were well received.

Just before the lunch break, Terry Fletcher, WAØITP, and Jim Kortge, K8IQY, introduced the new Four States kit (now available). The kit, called the

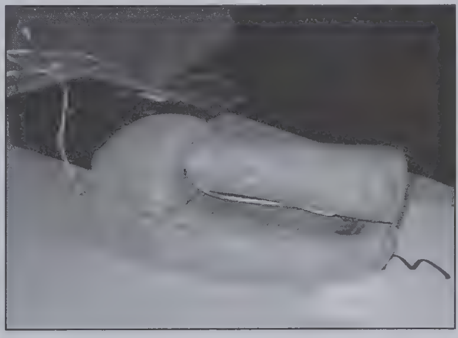
The Friday evening jam session provided musical entertainment.



Ozarkcon 2010 QRPer of the Year, Jim Kortge, K8IQY, speaks of the new Four States kit, the Magicbox, which he developed.

Magicbox, is a solid state fully functioning microprocessor based T/R switch providing seamless transceiving using separate transmitters and receivers. It is fully automatic and absolutely silent and is compatible with transmitters up to 10 watts. Further information on the Magicbox can be gotten from http://www.wa0itp.com/mbmagicbox.html.

Following lunch and spending time in the QRP swap meet, it was time for the afternoon session. The first speaker was Gerry Edson, WAØKNW, who spoke on "Uses of Diode Ring Double Balanced Mixers in Amateur Radio." He showed a schematic of a diode ring mixer and spoke of advantages over active mixers as well as disadvantages. He spoke of mixer impedance specified at 50 ohms and uses in up and down conversions. The mixers may be used as a balanced modulator, a phase detector or product detector. Gerry then got into using MMICs (miniature monolithic integrated circuits) and the use of a double sided pc board as an absolute requirement although there may be prob-



Note to Richard Bennet, KCØPET: Just *what* are you going to do with that carrot and potato...?

lems with plated through holes.

The final talk of the day was "Ham Salad" by Dave Cripe, NMØS. Dave said his talk was about QRP Radio Recipes for building. He felt the best way to approach a new project was to improvise on ingredients (parts) that you already have, follow are a few set rules, understand that a need must be filled, the build can be messy, the project does not have to be complicated and (this is important) it's fun to make. There is more than one definition of "homemade." A built commercial kit may be considered "homemade." Dave went through repeatability, classic components and their availability and minimal interfaces. The important thing is to have fun with your project. He felt you must think outside the box and don't be afraid of "magic" (what you don't know about). Dave showed us his 50 watt amplifier he built for the ARRL challenge for the cheapest amplifier. Dave did come in at second place but his amplifier is scheduled for an upcoming issue of *QST*.

All speakers were awarded plaques for their talks. Other plaques were also given out. The plaque for QRPer of the Year went to Jim Kortge, K8IQY. Plaques were given to Dar Piatt, W9HZC, and Darrel Swenson, KØAWB, for running the Hands on Kit Building Workshop. A plaque was given to Ron Potter, AG1P, for being the Master of Ceremonies.

The Grand Prize, an ATS-4 and Palm Paddle combo, was won by John Tudenham, WØJRP. The wacky key contest was won by Rick Bennett, KCØPET, who constructed a carrot and potato key right at the contest table.

After dinner, a bunch of us got together for an evening music jam. Ozarkcon again was a super event. Joe Porter, WØMQY, has stepped down from being in charge of setting up the meeting, but feels Ron Potter and others will fill right in. Joe did tell me as I left that they were in negotiations with the hotel to hold Ozarkcon there for the next five years. So, Ozarkcon should be in Branson again next year.

That is all I have for now. I do not have any meetings on my calendar to attend so will be looking to you for information on your club and its activities. Please let me know what is going on so I can tell the readers about it.

—72, Tim, WB9NLZ

QRP Clubs in America—Part 2

In my last article, QRP Clubs in America, I wrote that I had only covered clubs that had responded to my letter of inquiry and a couple others that I know about. I realized there had to be others out there and also Canadian clubs. So I went online and put in "QRP Clubs" and got pages of references about individual clubs as well as listings of clubs. Then, looking at listings, some clubs in one listing were not in another. So I put the listings that I found together and made up my own listing. If I missed your club I am very sorry and would ask that you let me know about it. If there was a website I did not list or have listed wrongly, please let me know about that also. I want this list to cover everybody. Honestly, I would love to hear from everybody so I could include everybody in my "Clubhouse" column.

—DE WB9NLZ

Club Name and Website	Location/Area Served
Adventure Radio Society http://adventure-radio.org	International
Alaska Club QRP Club http://qsl.net/kl7aqc	Alaska
American QRP Club http://www.amqrp.org	North America
Arizona Scorpions QRP Club http://www.azscqrpions.com	Arizona
Arkansas QRP Club http://www.qsl.net/nq5rp	Arkansas
Austin QRP Club http://www.qsl.net/kq5rpl	Austin, Texas
Brooklyn QRP Club http:/www.qsl.net/bklynqrp	Brooklyn, New York
Canada QRP Club http://qrpcanada.com	Canada
Cedar Forest QRP Club http://wilsonarc.wordpress.com	Middle Tennessee
Colorado QRP Club http://cqc.org	Colorado
Columbus QRP Club http://qsl.net/cqrp/main.html	Columbus, Ohio
CW Operators QRP Club, Inc http://users.on.net/~zietz/qrp/club2.htm	International
Durham Region QRP Club http://www.freewebs.com/drqrp	Durham Region, Ontario
Eastern Pennsylvania QRP Club http://n3epa.org	Eastern Pennsylvania
Flying Pigs QRP Club International http://fpqrp.com	International
Four State QRP Group http://4sqrp.com	Arkansas, Kansas, Missouri, Oklahoma
Ft. Smith QRP Group http://w5jay.net/ft_smith/fort.html	Ft. Smith, Arkansas

Gloucester Area QRP & Homebrewers http://angelfire.com/pe2/hott/G_QRP.html	Gloucester, VA
Hawaii QRP Club http://www.chem.hawaii.edu/uham/hiqrp.html	Hawaii
Houston QRP Club http://www.w5acm.net/hqrp.html	Houston, TX
Iowa QRP Club Geocities out	Iowa
Knightlites QRP Club http://knightlites.org	North Carolina
KY-QRP http://home.insightbb.com/~birdcam/kyqrp/KY-QRP/welcome.html	Kentucky
Lake Ferris QRP Society http://qsl.net/kr6lp	Riverside Country, CA
Little Thunder QRP Club http://qsl.net/ve3fal	Thunder Bay, Ontario
Long Island QRP Club http://qsl.net/liqrp/club.html	New York
Massantutten QRP Club http://cob.jmu.edu/fordham/mara/QRP%20Group.htm	Shenandoah Valley, VA
Michigan QRP Club http://qsl.net/miqrpclub	Michigan
Midwest Homebrewers & QRP Group http://qsl.net/hbqrp	Nebraska
Minnesota QRP Society http://www.mnqrp.org	Minnesota
NETXQRP Club http://angelfire.com/tx4/netxqrpclub	Northeast Texas
New England QRP Club http://newenglandqrp,oerg	New England
New Jersey QRP Club http://njqrp.org	New Jersey
North Georgia QRP: Club http://nogaqrp.org/mainpage.html	Northern Georgia, USA
NorCal http://norcalqrp.org	Northern California
North American QRP CW Club http://home.windstream.net/yoel	North America
Northern Vermont QRP Society http://wulfden.org.NVQS/mainpage.htm	Northern Vermont
NORTEX QRP Club http://www.kk5na,com/nortex.html	Northern Texas
NoVaQRP http://novaqrp.org	Northern Virginia
Ottawa Valley QRP Society http://qsl.net/va3ovq	Ottawa, Ontario
QRP Amateur Radio Club International http://qrparci.org	International
QRPp International http://indianapolis.net/QRPp- I/main.html	International
QRP Cheeseheads QRP http://qsl.net/nq9rp	Wisconsin
Reno QRP Group http://www.renoqrp.org	Reno, Nevada
Second Class Operators Club http://qsl.net/soc/	International
South West Ontario QRP Club http://users.imag.net/~low.jbcumming	South West Ontario
St. Louis QRP Society http://slqs.net	St. Louis, Missouri
Virginia QRP Society http://qsl.net/vqs	Virginia
West Florida QRP Club http://qsl.net/westfla	Tampa, Florida area

If your local or regional QRP club is not listed here, please send a note to QRP Clubhouse columnist Tim Stabler, WB9NLZ: wb9nlz@yahoo.com

Making Full Use of Ceramic Resonators

Dave Gordon-Smith—G3UUR daveg3uur@googlemail.com

Ceramic resonators usefully fill a gap between quartz crystals and LC circuits. Despite their unloaded Q, or Q_u, being considerably lower than that of quartz crystals, there are some applications where their particular mix of parameters comes in very handy. Amateurs have long used ceramic resonators in VXO circuits, but their use in homebrew filters has been pretty limited. The purpose of this article is to show a little of what can be done with them in this respect, and, hopefully, redress the balance a bit.

The first commercially produced ceramic resonators came out in the early 1960s. American, Japanese and European manufacturers saw the potential for using these little resonators in the mass production of broadcast radios and TV sets, and the demand for them grew steadily. During the 1970s, great improvements were made in long-term material stability and production methods. In about 1980, I tried using some Vernitron 559 kHz ceramic resonators in ladder filters, but these resonators didn't have high enough Q_u values to be really useful. They had been purchased from a surplus components dealer and were probably from the early 1970s. It wasn't until 1982 that I discovered how good Murata LF ceramic resonators were. Quite by chance, I found the Radio Shack store near where I was staying in the States was offering Murata CSB455E ceramic resonators at 2 for $1. When I checked out the motional parameters of the dozen or so I had bought, I was surprised to find their Qu values ranged from 2200 to 3000. That was high enough to be useful for making 2.7 kHz bandwidth filters with 8 or 10 resonators, or even 600 Hz bandwidth CW filters with 4 resonators, without excessive insertion loss or serious degradation of the –6 dB / –60 dB shape factor. Decent ceramic filters for SSB use, such as the CFJ455K5 and CFJ455K13 or 14, were not readily available then. You could get the CFS455J, which was claimed to have a minimum bandwidth of 3 kHz, but the one I bought was nearly 5 kHz wide at 6 dB down!

Having measured close to a hundred CSB455E ceramic resonators over the intervening years, I can tell you that they have Q_u values ranging from 1100 to 3300 with a distribution that is approximately Gaussian. The majority of resonators have Q_u values in the range 1700 to 2700, as you'd expect from this type of distribution, with roughly half of them being above 2200 and a few above 3000. I've checked 455kHz resonators from a number of other manufacturers and as yet have not found any that match, or come close to the performance of the best Murata CSB455E resonators. Murata also manufactured high-Q ceramic resonators on 500kHz (CSB500E) and 1MHz (CSB1000J). These make quite good filters too, but not quite as good as those on 455kHz. At the present time, Dan's Small Parts are offering CSB455E resonators at 2 for $1, which is the same price Radio Shack had them on offer in 1982! How's that for low inflation? Recently, I've found a ceramic resonator type CSBLA455KEC8-B0 marketed by Digikey (Part No. 490-1187-ND), which they claim is the same as the CSB455E. This is even cheaper in modest quantities!

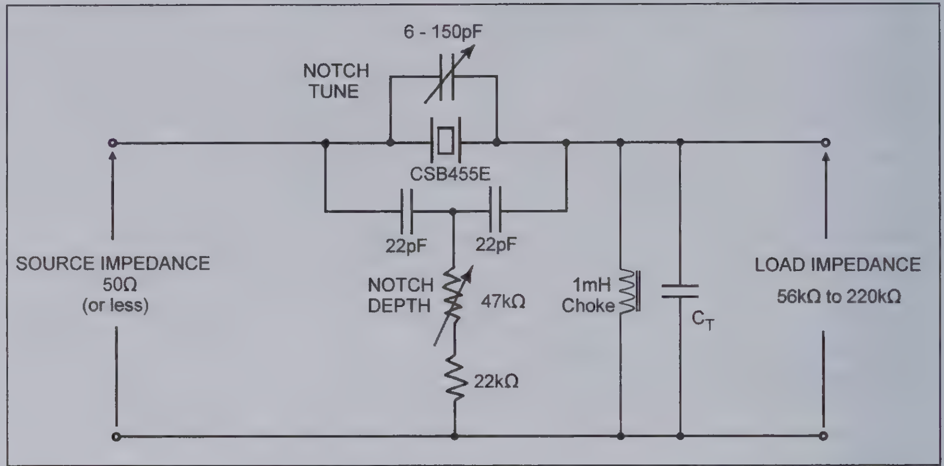


Figure 1—Circuit of a tunable notch filter using a Murata ceramic resonator (CSB455E) that is capable of providing 60 dB rejection over a narrow band that can be set anywhere between 452.5 and 457.5 kHz.

A Great Tunable Notch Filter

Tunable notch filters working at the IF of a receiver can be very effective at knocking out annoying heterodynes or adjacent interfering signals, particularly if they don't affect the spectrum of the recovered audio too much. The Q of the tuned circuit used in a notch filter determines both the depth and the width of the notch at the top of the response (around the -6dB level). It's the latter that determines how much the audio spectrum of the demodulated signal is affected by the notch. Figure 1 shows the circuit of a pretty sharp tunable notch filter using a Murata CSB455E. The resonator needs to be selected for an above-average value of Q_u, preferably 2700 or greater, and a moderately high parallel-resonant frequency. The latter determines how far above 455 kHz the notch can be tuned with the tuning capacitor at minimum. Usually ±2 kHz swing is adequate for use with SSB filters centred on 455 kHz, and the notch can be used to sharpen up either edge of the main filter response as well as null out heterodynes within the pass band. My first notch filter, built according to the circuit in Figure 1, tuned about 2.51 kHz below 455 kHz and 2.48 kHz above with a resonator that had a parallel-resonant frequency of around 458.4 kHz. Parallel-resonant frequencies of 457.9 to 458.9 kHz should allow a notch filter to be made with an overall tuning range of about 5 kHz, and at least 2 kHz swing above or below 455 kHz.

There are two solutions to the mathematical equation for optimising the notch depth: one that requires values of depth control resistance from about 15 kΩ upwards and one that requires values from about 5 kΩ downwards. The high-resis-

tance solution needs the resonator to have a parallel resonance about 900 Hz higher than the highest notch frequency. The low-resistance solution requires a resonator that only needs to have a resonance about 500 Hz above the highest notch frequency, so this difference can be used to advantage in equalising the tuning range on either side of 455 kHz.

Ideally, the variable resistor used to adjust the notch depth should be controlled from the front panel so that it can be tweaked for optimum performance on each frequency within the tuning range. The depth control could be mounted inside the receiver and pre-set for the best notch depth in the middle of the pass band, but this is likely to degrade its performance substantially at frequencies other than the one at which it's set. The notch is very sharp and can be more than 60 dB deep when the depth control resistance is adjusted for best results, but this optimum value of resistance varies with the frequency of the notch.

The 150 pF variable used to adjust the frequency of the notch has to be isolated from ground, and using the type that has a ceramic end plate with separate mounting pillars either side of the tuning shaft greatly eases this problem. It also requires a non-conducting extension shaft to minimise hand-capacitance effects. A 6:1 slow-motion drive can aid tuning, and a pointer is a useful indication of where the notch is set relative to the middle of the filter pass band. The frequency scale is quite asymmetrical, though, with 455 kHz being about 30º to one side of the centre point. The filter can be shorted out when not in use, or the notch parked at either end of the tuning range.

An emitter follower provides the right source impedance for driving the notch filter and a JFET stage with a 56 kΩ, 100 kΩ, or 220 kΩ gate resistor provides the right sort of load. Don't be tempted to make the total load for the notch filter too much higher than 220 kΩ as this can distort the shape of the notch at the top of its response and affects the spectrum of the recovered audio. Any shunt capacitance across the output also affects the symmetry of the notch above the –6 dB level, and that's the reason for the 1 mH miniature RF choke and its tuning capacitor (C_T) at the output. This circuit absorbs the input capacitance of the following stage if roughly tuned to

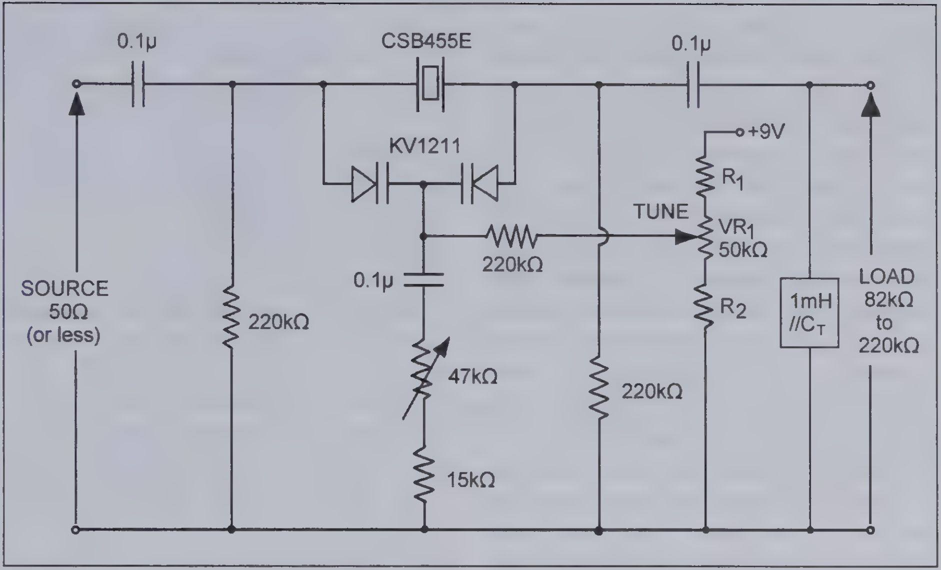


Figure 2—Varicap version of the tunable notch filter using a Murata ceramic resonator type CSB455E.

455kHz, or slightly above, and allows matching to lower impedance with a suitable series fixed capacitor instead of using a JFET stage, if desired. The parallel equivalent resistance of this arrangement must still be in the range 56 kΩ to 220 kΩ, though. In my filter CT is a 5-65 pF trimmer in parallel with 82 pF fixed.

A 56 kΩ load provides the best symmetry and greatest notch depth, but has a greater –6 dB bandwidth (450 Hz) than the 220 kΩ load (250 Hz). More than 60dB notch depth can be achieved routinely with a resonator of Q_u = 2900. Careful adjustment of the tuning and notch depth can achieve 70 dB around 455 kHz with a mid-range load of 100 kΩ, but this is tricky as the tuning and depth controls do seem to interact a bit as the notch gets deeper. The value of the depth control resistor from the capacitor centre tap to ground depends not only on the resonator Q_u and the frequency of the notch, but also on the value of the two nominally equal capacitors providing the tap. Making these two capacitors too small in value can create extra asymmetry at the top of the notch and also reduces the maximum depth of the notch. Increasing their value is fine, and this can be used to centre up the notch range when the resonator is too high in frequency.

It's advisable to use a suitable variable resistor to establish the range of notch-depth resistance required for your particular resonator and capacitors initially, and then when you know what they need to be you can work out whether the variable resistor can be reduced in value and supplemented with a series fixed resistor to improve the ease of adjustment. I used a 100 kΩ linear variable to establish the values for my original notch filter. It required 62.5 kΩ at 457.48 kHz and 24.4 kΩ at 452.49 kHz, and I decided to use a 22 kΩ fixed resistor in series with a 47 kΩ variable. Your resonator and capacitors may require different resistor values to mine, as they do seem to vary a bit from one resonator to another. As an alternative, of course, you may want to consider using the values for the low-resistance solution if they're more convenient. My second notch filter used a CSB455E that had a parallel-resonant frequency of 458.15 kHz and I used the low-resistance solution because it centred up the tuning range better. I ended up using my 5 kΩ test variable for the depth control because a more convenient variable with a lower resistance wasn't available in my junk box—a 2.5 kΩ variable in series with a 680Ω fixed resistor would have been ideal.

Figure 2 is a suggested circuit for a varicap-tuned version of the 455 kHz notch filter. A test circuit like the one shown was tried many moons ago using a KV1211 dual varicap, but was never extensively tested. One of the KV12XX series of varicaps was selected in preference to one from the MVAM series because of its higher Q. The selection of the right dual varicap is quite important to achieving the best

tuning range with a modest DC voltage swing. Ideally, the varicaps should be reasonably well matched and vary from less than 35 pF at 8 or 9 volts to over 300 pF at a voltage of more than 1 volt. R1 and R2 can be used to limit the voltage swing and spread the frequency range of the notch over the full 270º of the tuning potentiometer, VR1. The resistor values in these two positions depend on the varicaps used and the exact voltage required to tune them between the capacitance limits stated above. In the KV1211 test circuit the voltage range required was from 3V to 6.5V, so R1 was 27 kΩ and R2 was 22 kΩ. It's essential to regulate the tuning voltage for best stability, and that's why it's limited to 8 or 9 volts rather than 12. There's nothing special about the choice of a 50 kΩ potentiometer for VR1, the tuning control; it could just as well be 20 kΩ. The ideal law for this application is semi-logarithmic or linear-tapered, but if these are not available a linear one will do. Again, a reduction drive on the tuning potentiometer will make it easier to tune the notch bang on frequency.

Since only one ceramic resonator is used in each notch filter, the selection of a suitable resonator for the filter can be done simply by trying each one of the available batch in turn and assessing which one gives the best performance, or best compromise between notch depth and tuning range. The frequency stability of ceramic resonators with temperature is nowhere near as good as it is with quartz crystals, but simple measures can be used to help reduce drift. Completely surrounding the ceramic resonator with small blocks of expanded polystyrene can insulate it from rapid temperature fluctuations and slow down the frequency changes that inevitably occur with high-Q tuned circuits. Heat will still be conducted to the resonator by the copper tracks of a PCB or any connecting wires, but these can be made narrow to help reduce that effect as well.

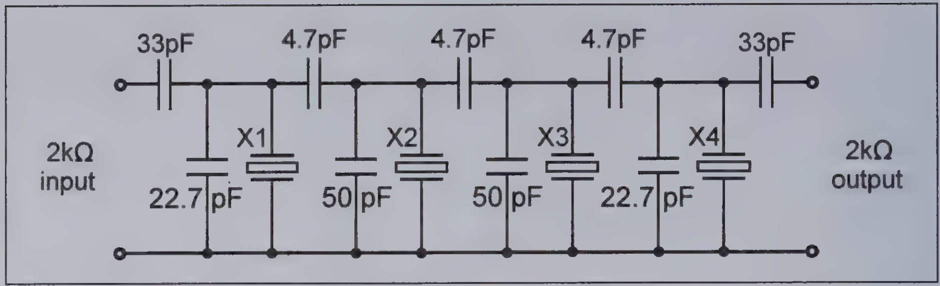


Figure 3—Circuit of 600 Hz bandwidth 4-pole USB ladder filter using Murata CSB455E ceramic resonators (F_C = 454.3 kHz).

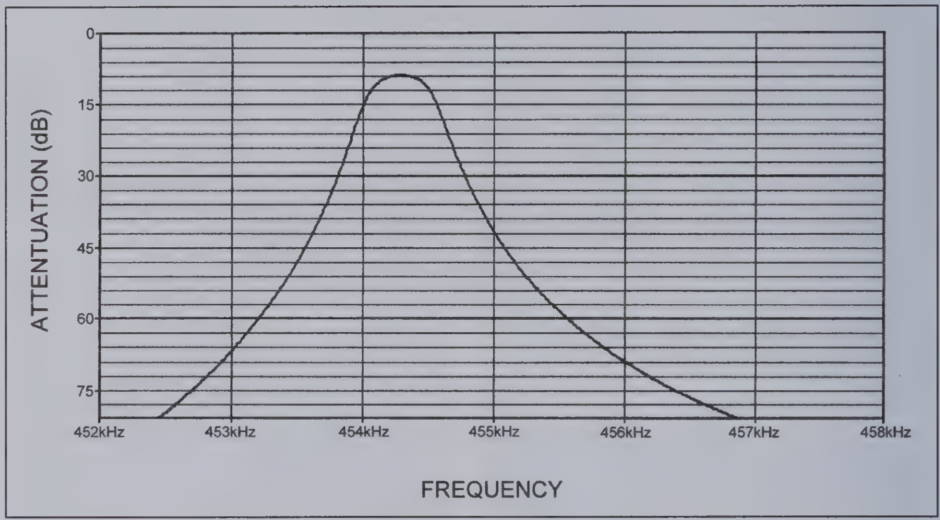


Figure 4—Frequency response of 600 Hz bandwidth 4-pole ceramic resonator ladder filter with 8.5 dB insertion loss.

A Cheap and Cheerful CW Filter

Specially selected CSB455E resonators can be used to make simple 4-pole CW filters centred on or around 455 kHz. Using resonators with Q_u values of 2200 and above, a filter with a –6dB bandwidth of 580 to 620 Hz can be made with an insertion loss between 6 and 10 dB. The latter figure may sound a bit high but mechanical filters with this sort of bandwidth generally have higher insertion loss than this. The characteristics of ceramic resonators make them more suitable for use in the Dishal USB ladder configuration shown in Figure 3. In this arrangement the ceramic resonators are used as parallel-tuned circuits coupled by small values of capacitance between them. The parallel capacitors across each resonator make up the overall capacitance seen by each one to the same total value (including coupling capacitors on either side). The values of parallel capacitance shown in the diagram are for identical resonators, tuned to 454.3 kHz, all with the same motional and static parameters, which in this case are equal to the typical values for this type of resonator. In practice these capacitors will need to take up the differences between the individual resonators, and are likely to be somewhat different to the values shown. The easiest way to deal with resonator variation is to use 5-65 pF trimmer capacitors in the prototype filter, and adjust them for the highest peak output on the desired centre frequency. This normally achieves a good passband shape and can be done in the target receiver, or externally using a signal source with 2 kΩ output resistance to drive the filter and an RF level detector or general coverage receiver, suitably terminated to provide a 2 kΩ load, monitoring the output. When the trimmers have been set, their capacitance values can be measured and the filter re-built using combinations of fixed capacitors in place of the trimmers to make the filter more compact. Miniature plate ceramic capacitors are ideal for this. The use of trimmers to set up the filter, initially, also allows the centre frequency to be adjusted to give the right beat frequency with any existing carrier crystals.

The terminating impedance of 2 kΩ matches that of other commonly available commercial ceramic filters. An insertion loss of 8.5 dB was obtained by the author for a 600 Hz filter using one resonator with a Q_u slightly below 2700, another with a

Q_u of around 2550 and two others with Q_u values just below 2200. The shape factor was about 5.6. The frequency response of this filter is shown in Figure 4. A second set of 4 ceramic resonators having Q_u values between 2700 and 3000 produced a 600 Hz filter with an insertion loss of less than 6 dB. Lower insertion loss figures can be obtained with the same resonators if the –6 dB bandwidth is broadened. By changing the 33 pF end capacitors to 39 pF and the coupling capacitors to 6.8 pF, a bandwidth of around 800 Hz can be produced with less insertion loss. Reducing the insertion loss by broadening the bandwidth, or using resonators with higher values of Q_u, has the added advantage of improving the shape factor—nearer 5 should be achievable with less than 6 dB insertion loss in this design.

Resonator Variation and Specification

Ceramic resonators can be characterised in the same way as quartz crystals if suitable test equipment is available. However, only loss and frequency need be measured to select Murata CSB455E resonators for use in the circuits described here. Resonator Q_u is the most important parameter for selection when considering a CW filter, especially with the simple arrangement described here because tuning out modest differences in frequency is just a simple matter of using a trimmer capacitor in parallel with each resonator in the prototype. However, the parallel-resonant frequency is equally important in the case of the notch filter if it's vital that the tuning range goes up to 457.5 kHz. Resonators for the 600 Hz CW filter only need to be matched to within ±500 Hz because they can be trimmed to frequency by at least this amount with a 65 pF trimmer. The normal spread of resonator frequencies is about ±2 kHz, so some selection is required.

If you're feeling lucky, four resonators could be chosen randomly from the batch, and the first version of the filter built with them. Then, by systematic substitution, the four that give the lowest insertion loss can be determined. Just run through all the other resonators in position 1 of the filter, one at a time, to see if any of them reduce the insertion loss compared with the original choice. Then move on to position 2, and so on, until all positions have been checked. If any resonators can't be trimmed to frequency they'll give higher insertion loss and be discarded anyway. It's tedious, but simple! On the other hand, you could wait until ceramic resonator characterisation is covered, hopefully in the next issue of *QQ*.

When higher or lower centre frequencies are required, it's just a matter of decreasing or increasing the total capacitance seen by each resonator appropriately. A rule of thumb is about 25 pF/kHz around 454 to 455 kHz, but this varies a lot according to how far the required centre frequency is from an individual resonator's series-resonant frequency and one with a resonance 2 kHz higher than the average would require 40 pF for the same 1 kHz shift. In order to get a centre frequency of 455.7 kHz, it would require the two end resonators to be higher in frequency than the inner pair and closely matched so that little or no capacitance would be needed to trim them to frequency—they "see" 32 pF of the 33 pF matching capacitance across them, and combined with the 4.7 pF from the coupling capacitor this gives a total of 36.7 pF before any additional parallel capacitance is added. That's why a centre frequency of 454.3 kHz was chosen for the design shown in Figure 3, so more parallel tuning capacitance could be used to match up the differences. It gives a beat of around 800 Hz with a 453.5 kHz carrier oscillator, so should be fine for most applications.

Final Comments

LF ceramic resonators are available on a number of commonly used IF filter frequencies, and the possibility of making filters with these resonators is quite attractive because of their low cost and the fact that their resonant frequencies can be trimmed more easily and much further than quartz crystals. However, the Q_u values of these resonators can vary significantly from one manufacturer to another, and some caution is required before shelling out good money for larger quantities. It's wise to buy a small sample to test, in the first instance, to see if they're any good. Recently, I was given eight ZTB455E ceramic resonators to try. There are no manufacturer's markings on them, though the "ZTB" prefix may indicate who made them. Of the eight, six had Q_u values around 2400, and the other two were around 1400. I used four of the six good ones to make a 600 Hz filter, as per Figure 3, and its response was much the same as that shown in Figure 4 with a similar insertion loss of around 8.5 dB. Considering the small quantity, though, this was amazing good luck.

Quite a range of HF ceramic resonators are available these days and they can be used in front-end filters as well as VXOs, but potential users should be aware that these resonators do not have as good a strong signal handling capability as quartz resonators. A simple procedure for designing USB ladder filters was described by the author several years ago in *QEX* [1], and could be applied equally well to front-end filters using HF resonators and IF filters using LF resonators. In addition to standard frequencies within the lower amateur bands, there are several standard frequencies available just outside the amateur bands, which are very handy as well. Resonators on 3.12 or 4.03 MHz, for example, can provide the basis for a VXO with modest tuning range, which could be used as the local oscillator source for a nice little 80-meter CW receiver with the 600 Hz filter described in this article.

The availability of both ceramic resonators and quartz crystals on the same frequency opens up some interesting possibilities for constructors. For example, 1 MHz quartz crystals are available as a standard item, and so are 1 MHz ceramic resonators. Together they offer the possibility of making both wide and narrow IF filters for a dual-band receiver covering the 80-meter and 160-meter bands with a local oscillator tuning 2.5 to 3.0 MHz. A selected high-Q, 1 MHz ceramic resonator (Murata CSBLA1M00J58-B0?) could be used for the notch filter. There are lots of possibilities. Have fun!

References

1. Dave Gordon-Smith, G3UUR, "Ceramic Resonator Ladder Filters," *QEX*, March/April 2007, pp 55-58.

Don't forget to check the QRP ARCI web site regularly!

The Clackamas Superheterodyne CW Transceiver

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Here is one of the runner-up entries in the FDIM Challenge to build a working transceiver using just 72 parts.

When I heard in January 2010 that QRP ARCI would be sponsoring a new design challenge at Four Days In May, I got more excited about designing a new radio than I have in a long time. I commend the creation of this 72-part challenge, as it was one of the most difficult yet rewarding experiences that I've ever had in my homebrewing and radio design career. I'm pleased to present my entry into the contest: the Clackamas superheterodyne transceiver.

Block Diagram

The topology of the Clackamas follows that of a typical single-conversion superheterodyne. The signal coming into the receiver front end passes through the transmitter low pass filter and a DPDT T/R switch. A single-tuned circuit provides bandpass filtering to knock down strong out-of-band signals. The desired 40 meter signal is then downconverted to the 4.032 MHz intermediate frequency and amplified by approximately 8 dB. A simple Colpitts crystal oscillator running at 11.059 MHz provides the local oscillator signal to both the receive and transmit mixers.

Intermediate frequency filtering is provided by a 2-pole 4.032 MHz crystal ladder filter with a nominal bandwidth of 450 Hz. This filter is coupled via L-network to a simple bipolar IF amplifier with approximately 27 dB of gain. The combination product detector/beat frequency oscillator downconverts the IF signal to audio frequencies while amplifying it by 10 dB. The audio signal is then fed into a TDA7052 audio amplifier, which provides ample gain to drive headphones.

The heart of the transmitter is a N-channel JFET active mixer, which takes the LO signal and mixes it with a Colpitts carrier oscillator coupled to the gate. The output of the active mixer is filtered with a double-tuned circuit before being lightly coupled to the BS170 power amplifier. Transmitter filtering is provided by a standard 5-element low pass filter.

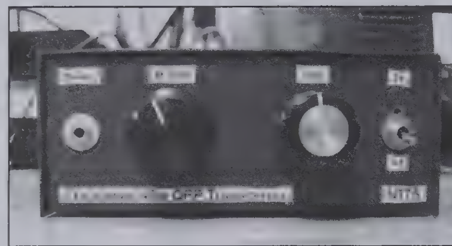

Figure 1—Front panel of the 72-Part FDIM Challenge radio.

Design Strategy

Even though the rules of the Challenge limited us to one integrated circuit (without penalty), I knew that I would need to find a way to include circuits that resembled ICs, in the sense that they would need to be able to perform or combine functions in as few parts as possible. Immediately, it seemed to make the most sense to try to work with dualgate MOSFETs. I've had a large store of BF998 dual-gate MOSFETs in my junkbox for many years, courtesy of KE6F (via W7ZOI's website).

Over the last few years, I had experimented with the BF998 and was able to successfully use them as amplifiers but never had much luck getting them to work correctly as active mixers. Going back to many of my reference books published in the 70s and 80s, it was easy to find lots of dual-gate MOSFET circuits, but the biasing schemes presented never worked correctly with the BF998.

To make a very long story short, after much pain and suffering I was able to tackle the two main impediments to implementing my dual-gate MOSFET strategy: biasing the BF998 for use as a decent performing mixer and figuring out how to configure the BF998 to function as a combination product detector and BFO. Once these challenges were tackled, the rest of the transceiver fell into place with only a moderate amount of difficulty. It should be noted that I scrapped the whole idea of using dual-gate MOSFETs twice so that I could try different design avenues, but none of the alternative strategies could yield a parts count even close to 72. Eventually perseverance paid off, and I was able to get my original design idea to work after a lot of experimentation.

One of the greatest advantages of using FETs is the relaxation of the need for high oscillator drive levels. This allowed me to cut all of the oscillators to bare-minimum functional units, with no buffering necessary due to the very light loading from high input impedances of the FETs. I would have liked to have used FETs throughout the entire rig, but the parts count limitation demanded that I use a bipolar transistor amplifier in the IF, so I also stuck with bipolar oscillator circuits since they are cheap and nearly bulletproof.

Pedigree

It is very clear that the Clackamas can draw its lineage from the series of minimalist superhet receivers that Doug DeMaw, W1FB published in the late 70s.

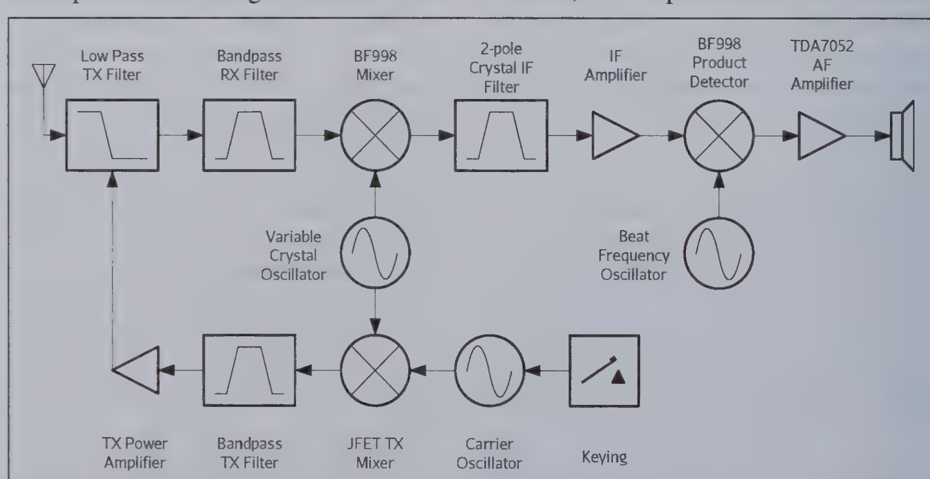

Figure 2—Block diagram of the Clackamas transceiver.

While I did not strive to copy these designs, there is only a small number of ways that one can configure a minimal parts count superhet using dual-gate MOSFETs. Let there be no doubt that the Clackamas was not a simple cut-and-paste job. While its design may be similar to the W1FB classics, it took quite a bit of work to modernize the circuits and pare them down to an absolute minimum of parts.

Perhaps the greatest inspiration for the Clackamas came from the W1FB combination product detector and BFO. Without this critical bit of parts-saving circuitry, I think that my task would have been nearly impossible to achieve.

Much credit also goes to the wonderful work of Wes Hayward, W7ZOI. His work in the homebrewer classics such as Solid State Design for the Radio Amateur and Experimental Methods in RF Design have provided me with an invaluable education in practical circuits that can get the job done. His S7C design was especially influential in the design of the Clackamas.

Specifications:

General

Frequency Range: 7.029 – 7.0325 MHz

Receiver

IF Bandwidth: 462 Hz
MDS: –126 dBm
3rd Order DR (20 kHz): 80.5 dB
IIP3 (20 kHz): –5.2 dBm
Blocking DR (20 kHz): 102.6 dB
IF Rejection: 23 dB
Image Rejection: 48 dB
Current Consumption (13.8 VDC): 50 mA

Transmitter

Power Output (13.8 VDC): 1.7 W
Current Consumption (13.8 VDC): 260 mA
Spectral Purity: <–40 dBc

Design Commentary

Front End

A light bit of bandpass filtering is provided by a singletuned circuit in the receiver front end. I was a bit concerned about the ability of a single-tuned circuit to provide any meaningful filtering of the very strong adjacent signals one generally encounters in the 40 meter band, but the filter worked surprisingly well. Of course, the conditions on 40 meters tends to be easier here on the West Coast of the United States than they are in other places, so this design may not be as suitable in those areas. The standing current in Q6 (the BF998 mixer) is very small; only a few hundred microamps. When I was working on the development of the mixer, I tried to increase the standing current by reducing R9 and providing bias to gate 1. It wasn't difficult to get the standing current to a few milliamps, but a large problem manifested itself. Increasing the standing current also triggered a very significant degradation in the noise figure (especially if bias was added to gate 1). Reducing the standing current made the receiver quite deaf. By quite a bit of trial and error, I was able to find a value of R9 that provided the sweet spot between excessive noise and insufficient gain. This is not my favorite way to design circuits, but I still don't have a firm grasp on all of the nuances of using the BF998 as a mixer, so using a purely experimental method is the best that I could do under the circumstances.

Crystal Ladder Filter

There is nothing particularly interesting about the 2-pole crystal IF filter. The filter was designed for a 450 Hz bandwidth with the xlad program from the Experimental Methods in RF Design supplementary CD using common 4.032 MHz crystals. The terminating impedance of the filter ended up being about 225 Ù. T2 provides the impedance transformation from the Q6 drain impedance of approximately 1.2 kÙ, while an L-network formed from C10 and L2 match the filter to the 50 Ù input impedance of the IF amplifier.

Product Detector/Beat Frequency Oscillator

In my view, the greatest breakthrough in the design of this radio was the completion of the combination product detector/BFO. As I found though experimentation, the only reason that this circuit can work is because the IF signal at RF frequencies is converted down to baseband. In order for Q7 to be able to oscillate at 4.032 MHz, the drain has to be bypassed to ground at that frequency (just as you would expect a Colpitts to be configured) while allowing the AF signals to remain on the drain. As far as I can tell, there is no way to configure this circuit to work as a front end mixer (where you would move a RF signal to another RF frequency).

Audio Amplifier

The audio amplifier is so dead simple there is very little to say about it. The selection of the TDA7052 was a virtual nobrainer, since I knew that it needed very little supporting circuitry in order work. It turns out that I was able to get it to function reasonably well completely on its own, with no decoupling on the VCC rail. There's more than enough audio gain from this amplifier. You can't beat 40 dB of audio amplification and 1 watt of available AF power for a grand total of 1 part.

Variable Crystal Oscillator

There's nothing particularly interesting about the VXO. It is a standard Colpitts VXO with polyvaricon tuning. Because it only needs to drive high impedance FET gates, there's no need for buffering. Drive levels to the receiver and transmitter mixers were set by experimentally changing the coupling capacitors (C20 and C29).

Carrier Oscillator and Transmit Mixer

The carrier oscillator is nearly an exact copy of the VXO, with two important exceptions. A large inductor was needed in series with the crystal in order to pull the oscillator onto the right side of the IF filter skirt. Since I ran low on parts, I found that I was able to leave the normal 100 nF decoupling capacitor off of the collector. Once again, due to the fact that the CO is driving a FET gate, no buffering was necessary. Transmitter keying is provided by grounding the emitter leg of the carrier oscillator. Normally, directly keying an oscillator is a big faux pas. However, the CO is so lightly loaded by the transmit mixer that no noticeable chirp is detectable during keying.

It took a bit of work to find a workable transmit mixer. It was always my desire to use an active device as a mixer, but I encountered quite a bit of difficulty in taming the mixers that I initially tried. Passive mixers were found to be unsuitable because they provided conversion loss instead of conversion gain and could not directly drive the following stages. After quite a bit of experimentation, I found that a J310 was the ideal choice for this application. I was a bit concerned that the unbuffered VXO could not drive the source of Q4, but it turned out to not be a problem at all. The necessary bandpass filter is incorporated into the drain of the transmit mix JFET.

Transmit Power Amplifier

I initially knew that I wanted to use a simple MOSFET PA such as a 2N7000, BS170, or IRF510. The IRF510 was ruled out almost immediately because the simple transmit mixer could not drive the relatively large gate capacitance. The 2N7000 and the BS170 are nearly identical, but the BS170 can handle quite a bit more current than then 2N7000, so it made more sense to use the BS170 as a PA (as evidenced by many of the new QRP kits coming on to the market place). Although I wanted to drive the PA in class C mode, I found that I could not extract much power from the amplifier in class C using this circuit. Through some more experimentation, I found that PA required a bit of gate bias in order to produce a reasonable amount of power output.

Blue LED D1 provides a stable gate bias voltage under varying power supply voltage changes. In order to achieve maximum power transfer, the double-tuned transmit mixer bandpass filter also needed to be adjusted to compensate for the input capacitance of Q2 by reducing the value of C22.

T/R Switching and Sidetone

It would be nice to have QSK, but realistically I knew that wasn't likely in a minimal parts rig. Therefore, the T/R switching is a simple DPDT switch. One pole switches the receiver path to the antenna out during transmit. The other pole switches power to the transmitter and receiver sections appropriately.

The sidetone is a pure hack but it works surprisingly well. Quite a bit of time was spent trying out different muting schemes where I would attempt to let a small bit of the transmitted signal back into the front end so the actual signal could me monitored as the sidetone. I never could get this level to anything lower than a roar, so I had to approach the problem differently. In a brainstorm, I figured out that I could just cut power to all of the receiver stages except for the product detector/BFO and audio amplifier. Now, the product detector picks up the stray carrier oscillator signal and downconverts it to a nice sidetone which accurately reflects the offset between the transmitted and received signal frequencies.

Attaining Zen

Not surprisingly, I was forced to evaluate the necessity of every single part in the rig. Sometimes as designers we will do this exercise on a circuit block, but rarely is it necessary to perform it on the entire radio. One excellent side effect of the requirement to do this is that I have learned much about what is really absolutely vital to include in each circuit, what provides nice but marginal performance improvements, and what is superfluous. I have no doubt that this hard won knowledge will be very useful in the future.

What Would I Put Back In?

Now that the Clackamas is cut down to the bare bones, there are some things I might add back in if I wanted to increase the operating conveniences and improve the performance.

- More effective decoupling would be one of the first things on my list. I was able to remove quite a bit of the decoupling with a minimal performance hit, but I would feel much more comfortable with the proper decoupling in the radio.
- It would be great to stick with using the BF998 throughout the Clackamas. If the IF amplifier was replaced with a BF998-based version, the receive current consumption could be reduced below 10 mA.
- Two poles of crystal filtering is a bit light for my taste. The biggest problem with the 2-pole filter is that the ultimate attenuation is only about 50 dB, so you can hear strong nearby signals. A 4-pole filter would be an excellent substitution.
- Due to the very light bandpass filtering on the front end and the fact that the mixer amplifies everything that gets to gate 1, the IF and image rejection is pretty poor. In order to fix this, I would change this filter to at least a double-tuned circuit, perhaps even triple-tuned.
- The simple keying and muting in the Clackamas works very well for the parts count, but semi-QSK keying and muting would be a nice convenience feature.
- The tuning range of the VXO is a bit restricted, so the addition of a second parallel 11.059 MHz crystal, plus perhaps a series inductor, would give a much greater tuning range.

A Suggestion

I really enjoyed the FDIM QRP challenge, but would like to suggest one rule change if QRP ARCI decides to conduct a similar restricted parts count contest in the future. Please allow for any tuned network in a transmitter output stage to count for a maximum of three parts, no matter the actual parts count. This rule comes from the Minimal Art Session in Germany, and would allow the designer to not have to worry about trading off spectral purity for a critical feature elsewhere in the radio.

Finally...

I wanted to spend a few moments to praise all of the wonderful design tools that I used in the creation of the Clackamas. All of the major tools that I used are free, open source software. This includes the Ubuntu 10.04 operating system, the wonderful OpenOffice.org suite, and TinyCad schematic capture. Where I didn't have open source software, I was able to run programs such as the extremely useful EMRFD tools under WINE Windows emulation. It is truly amazing how today's designer and builder has access to professional quality tools for little or no money.

Editor's Note: Other entries in the FDIM 72-Part Challenge are planned for publication in future issues of *QRP Quarterly.* Be sure to see KE6TI's winning entry in the FDIM Challenge, starting on page 18 of this issue.

And don't forget—any homebrew project you make might be a good article for *QQ*! To find out, just send a note to the Editor, or to any of the Associate Editors, with a brief description of your work.

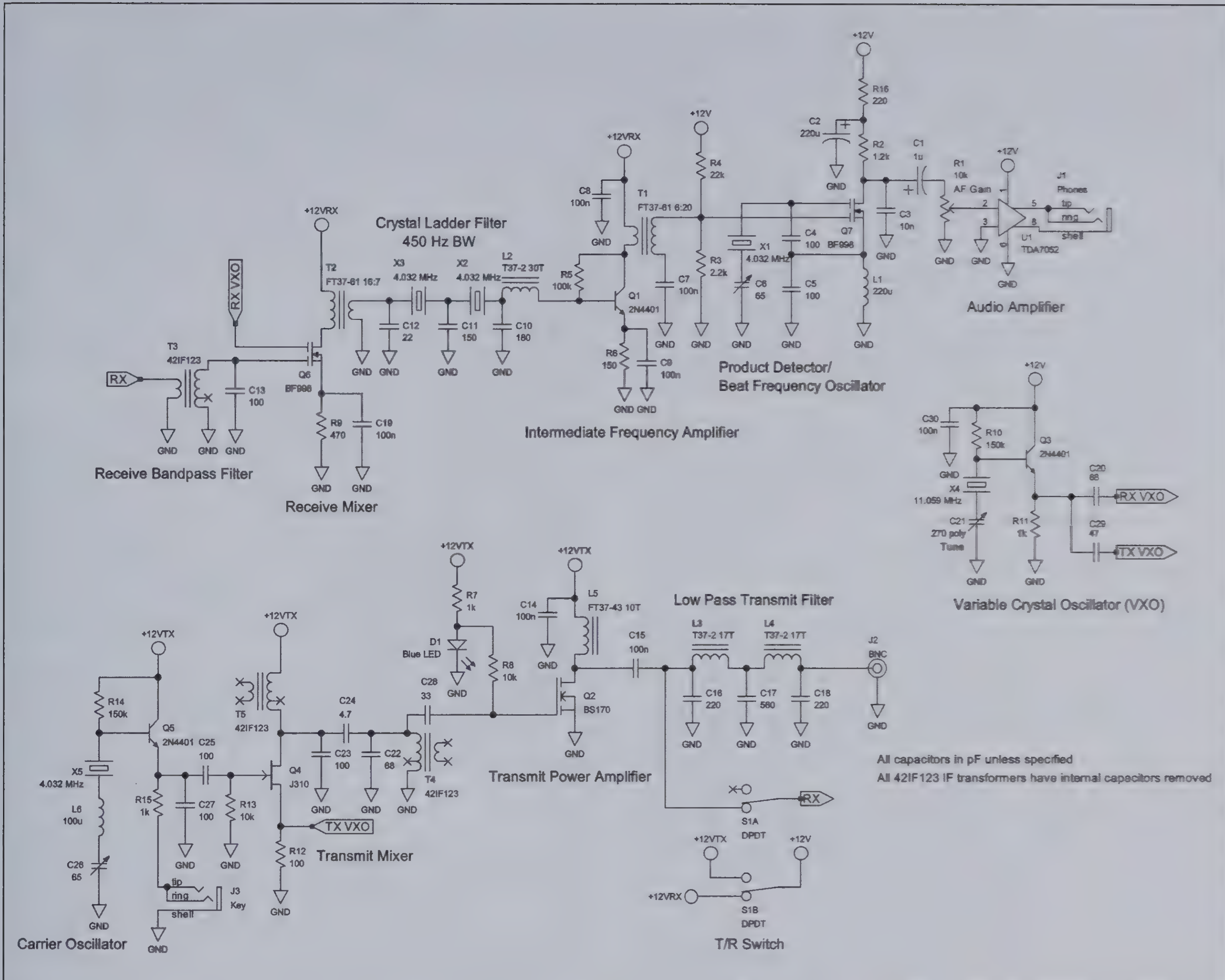

Figure 3—Schematic diagram of the Clackamas 72-part radio.

Bill of Materials

Resistors (all 0.25 W)

R1, R8, R13	3	10k
R2	1	1.2k
R3	1	2.2k
R4	1	22k
R5	1	100k
R6	1	150
R7, R11, R15	3	1k
R9	1	470
R10, R14	2	150k
R12	1	100
R16	1	220

Capacitors (all 25 WVDC min., all values pF—unless specified)

C1	1	1u
C2	1	220u
C3	1	10n
C4, C5, C13, C23, C25, C27	6	100
C6, C26 (trimmer)	2	65
C7, C8, C9, C14, C15, C19, C30	7	100n
C10	1	180
C11	1	150
C12	1	22
C16, C18	2	220 (50 V)
C17	1	560 (50 V)
C20, C22	2	68
C21 (polyvaricon)	1	270
C24	1	4.7
C28	1	33
C29	1	47

Transistors

Q1, Q3, Q5	3	2N4401
Q2	1	BS170
Q4	1	J310
Q6, Q7	2	BF998

Inductors

L1 (molded)	1	220u
L2	1	T37-2 30T
L3,L4	2	T37-2 17T
L5	1	FT37-43 10T
L6	1	100u

Transformers

T1	1	FT37-61 6:20
T2	1	FT37-61 16:7
T3, T4, T5	3	Toko 42IF123

ICs

U1	1	TDA7052

Miscellaneous

X1, X2, X3, X5	4	4.032 MHz
X4	1	11.059 MHz
D1	1	Blue LED
S1	1	DPDT

Total Parts = 72

Not included in parts count

J1	1	3.5 mm
J2	1	BNC
J3	1	3.5 mm

Figure 4—Parts list, including other items allowed in the FDIM Challenge rules.

Making a Software Defined Radio for the QRP Enthusiast—Part III

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In the last issue of this magazine, I began to describe the software used in my self-contained (no PC) Software Defined Radio (SDR). Major points of this description were the integrated development environment, board support, user interface, and generation of a single sideband signal. At that point, the receiver could be tuned and a sideband selected. However, the receiver still lacked the filters necessary to a practical transceiver. A discussion of the methods used to implement those filters and the things I learned along the way toward that implementation will form this part of my article.

There are many different ways to do filtering and even a cursory discussion of the major players is beyond the scope of this paper. For the purposes of this article I will describe two ways I've implemented filtering. But before I describe how I did my filtering, I'm going to need to describe two of the most fundamental principles of Digital Signal Processing: Correlation and Fourier Transforms. No… don't stop reading… I'm going to try to present each of these concepts in a very informal matter. I'll gloss over all of the math and all the nitty-gritty and try to show you this stuff can be intuitive and very powerful………

In reading through the literature I often heard the terms "in the time domain" and "in the frequency domain." I have learned that at best these terms are hints as to the view point of the author and convention. In theory there is no difference between "time domain" and "frequency domain" and that means you are free to think about the problem in either way. Indeed, the only reason one thinks "frequency" instead of "time" is one of convenience and simplification. For example, if you are like me, you tend to think of filters as working in the "frequency domain." I think, "I want to pass some frequencies and block others." Thus, when thinking about designing filters I want to think in "frequency." However, CODEC samples come periodically in "time," and so when implementing filters I may want to program in "time."

This ability to work "in the frequency domain" is hugely powerful. Now I'm going to exaggerate a little… I can say "remove any 1 kHz component" and get exactly that. I can say "boost all frequencies below 1500 Hz by 20%" and get exactly that. I can say, "change the phase of the 750 Hz component of the signal." All these capabilities come from a single technology: the Discrete Fourier Transform. But to get to the DFT you really need to start with something I found even less familiar: *correlation*.

Now over the last few years I've tried to understand digital filters and how to explain them to others without using too much math. What follows are my best attempts to date. I am going to brush over some pretty important "secondary" effects. I do this consciously so as to deliver the material in an intuitive and natural progression. As you read further on this topic you will no doubt find critical details I have left out. When you do, please accept my apologies. Let's get started.

Correlation

What is "correlation"? Simply put, correlation is a method used to measure similarities—"How alike are A and B?" Suppose A and B are collections (arrays) of CODEC samples each 100 samples long. Suppose further that B is an array which was created by sampling a 600 Hz signal. If I then compare A and B and find them "very similar," then I know there is a lot of 600 Hz signal in A. If they are not similar at all, then I know there isn't any 600 Hz in A. The result of a correlation is a numeric value we'll call H. We'll say H=1 if the A array looks exactly like the B array and H=–1 if A is the negative of B. We'll say H = 0 when A is nothing like B. H can thus take on any value $-1<H<1$.

(NOTE: When writing about these issues it is convenient to develop a terminology to simplify writing and reading. For example, we will need to refer to arrays of numbers. When I want to refer to the "B Array" I will write "B[ ]"… the "[ ]" can be read directly as "Array." When I want to talk about an array which contains a signal with a specific frequency I'll write "B(freq)[ ]." As an example, "B(600)[ ]" is the "B Array containing 600 Hz." (Note that B(600)[ ] is not really a recording of a 600 Hz signal; the contents of B(600)[ ] are computed using the sine or cosine functions provided by Microchip.)

Correlation can be used to implement a filter. To do so, I compare A to B to generate H. Correlation is very fast and I can compute a new H every CODEC sample period. I can then send H directly to the CODEC for output. Yes, directly. To see why, consider the following. When the signals in A and B are both 600 Hz and "in phase" then H will be a 1; A is equal to B. During the next CODEC sample the phase of A[ ] will be different and A will look "mostly like" B and so H will be somewhat less than 1. As time progresses A will eventually look like the negative of B and H will be –1. Again, time progresses and A will again look exactly like B and H will be 1 again. In fact, H will cycle from 1 to –1 and back to 1 at 600 Hz. Yep, a filter. A more in depth presentation of this material can be found at http://www.ae6ty.com/Intro2SDR/SDRnoMath.html.

Now just exactly how does correlation compare A to B? Well, it is really quite simple. Correlation multiplies each element in A by the corresponding element in B and then adds up the products. Stated a little more succinctly:

H = SUM(A[i] x B[i]) for all i

We can write the program for correlation in C. Loops in C are written using a "for" statement. For A[ ] and B[ ] arrays which are 100 elements long, we would write:

```
H = 0;                     //initialize our sum.
for (i=0;i<100;i=i+1)      //for all i in A[ ] and B[ ]
H = H + A[i]*B[i];         //multiply and accumulate.
```

Now before we proceed I want to drive home how important this is. Correlation allows me to compare two signals and get a numerical figure of merit. This simple concept is the basis for everything that follows.

"But," you say, "Suppose I want a filter which passes more

than a single frequency? Suppose I'd like to pass frequencies 600 and 650?" Well, then we would do a correlation with B(600Hz) and a second for B(650Hz) and then add the two together. Thinking ahead you can see a problem: for a wide filter I'd need to do a whole bunch of correlations and that sounds like a lot of processing time and it WOULD BE but, of course, there is a short cut.

Instead of performing a bunch of correlations and then adding the results I could add the results along the way. I would write the code:

```
H = 0;
for (i=0;i<256;i=i+1)
  {
      H = H + A[i]*B(600Hz)[i];          // 600 Hz.
      H = H + A[i]*B(650Hz)[i];          // 650 Hz.
  }
```

This reduces the loop overhead but it is still an awful lot of multiplies. Fortunately, there is yet another simplification. I can add all the B(600Hz)[ ] and B(650Hz)[ ] arrays together. After all, high school algebra says that ab+ac=a(b+c) and so H = A*B + A*C = A(B+C). We can call this new array F[ ] and make F[ ] = B(600Hz)[ ] + B(650Hz)[ ]. Then instead of doing 2 multiplies inside the loop we do one. (The F[ ] array is often called the "filter kernel" or "impulse response" in the literature.) Thus, the program now looks like:

```
H = 0;
for (i=0;i<256;i=i+1)
  {
      H = H + F(600Hz)[i];       // F contains 600 and 650 Hz.
  }
```

Further, F[ ] is simply the sum of all the B[ ] arrays of all the signals we want to detect. If we want to detect 600 and 650 and 700 and 750 we simply add the B(600 Hz)[ ], B(650 Hz)[ ], B(700 Hz)[ ] and B(750 Hz)[ ] arrays. Since the B[ ] arrays are actually generated in software the entire F[ ] array can also be generated in software. This means that any filter shape can be implemented using the simple correlation routine shown above. Thus, all filters will take the same amount of time to process. This is very, very cool!

Oh and wait—remember all those weird filter cases we wanted, say notching or boosting? Well, we just take that into account when generating F[ ] and we're done. Really. Almost everything else you'll need to know about a basic DSP filtering is an optimization on how to create F[ ] or perform the correlation faster or make the correlation more precise. Here's an example…

Fourier Transform

Now let's think about the dreaded Fourier Transform. Early on in this project my eyes glazed over and I thought, "Yah Yah, but tell me how to do this stuff without Fourier Transforms, PLEASE!" After all, all the books on the subject are filled with integrals and talk about the Fourier Transform and how to implement it and how to make it fast and how clever the mathematicians were… and they were clever.

But the engineers who design cars are very clever and most drivers are not engineers. he same is true with Fourier Transforms; you can drive this car too. Early on I avoided the whole Fourier Transform view but I found that I was designing filters by formula. As I said before, we hobbyists have time to ponder and I was determined to break through the Fourier Transform barrier. I hope to help you get through this barrier as well.

The first step in breaching the Fourier Transform barrier is to simply accept a few realities.

First, just as with correlation, the Fourier Transform works on blocks of data. Accumulating, processing and delivering these blocks of data require a certain amount of logistical overhead in the programming. These are simply facts of life.

The second reality: generally speaking, larger blocks of data produce more precise results. This means that more precise results require more memory for the blocks of data and longer delays through your system. There are ways to reduce these delays but the facts remain; you want better results you're going to have to wait.

The third reality: you can probably write the code to do the Discrete Fourier Transform and it is a fascinating exercise I heartily recommend. But, you'll probably want to use a software library where someone spent lots of time making it as fast as possible. Don't get me wrong, there are many Fourier Transform applications which do not require blazing speed and I'll show you a couple later on. For now, though, let's just assume we have the appropriate software packages.

Now to simplify the discussion, I'd like to eliminate a few variables. First, let's assume all blocks of data are 100 samples long. Further, let's assume the CODEC sample rate is 100 Hz. Once we're comfortable with this simplified situation we can simply scale things. This is much like how one designs analog filters for an " =1" frequency and then scales up to the desired frequencies.

To get things started we gather up 100 CODEC samples and place them in an Input array we'll call I[ ]. The Digital Fourier Transform (DFT) then takes I[ ] and produces a second block of data which is also 100 entries long. This second block of data is, in effect, the "Spectrum" of the input block and we will call the second array the "S[ ]." The first element in this array is the "DC" value of the CODEC samples. The second element is the magnitude of 1 Hz in the signal. The third represents the magnitude of 2 Hz, the fourth 3 Hz, the fifth 4 Hz, etc. Importantly, the Spectrum Array (S[ ]) contains both upper and lower sideband spectra but let's ignore that for the moment. Authors better than I can explain these details. For now, let's just think about the lower half of the S[ ] and assume the upper half is always zero or we will MAKE it zero.

But how does each element S[i] get generated? Well, it is generated using correlation. Yep. For each "i" in S[ ] we compute S[i] = Correlation(I[ ],B(iHz)[ ]). Really, that is it. The DFT is just bunch of correlations. All the math, all the pretty graphs, all the shorthand descriptions, all the chapters on algorithms are descriptions of this simple idea: the DFT is simply a convenient collection of correlations. Don't be intimidated and don't get lost. All that math is there to help us write programs, not necessarily to help us understand.

Unfortunately, the math does tell us there is one more compli-

cation. If you think back to the very first correlation we did you'll remember that there was a point at which the correlation was zero even though the input array A[ ] and the reference array B[ ] were very similar, specifically when the two waveforms were 90 degrees out of phase. This was fine for our correlation filter but represents a problem with the DFT. Surely the I[ ] contains a signal of frequency "i." We will want S[i] to reflect that fact REGARDLESS of the phase!

The DFT avoids this problem by performing the correlation with both a sine wave and a cosine wave for each frequency. Then, independent of the phase of the signal, the appropriate DFT bin will not be zero. The DFT records the correlation for the cosine and sine waves by making each S[ ] element a complex number. The "real"part of the S[ ] element represents the correlation with the cosine and the "imaginary" part is the correlation with the sine wave. Now, just to keep things simple, we'll ignore the fact that the S[ ] elements are complex numbers. It is vastly important but let's just forget it for the time being.

Once we have the S[ ] we can process each element in that array as we see fit. For example, if you want a really narrow filter at, say, 6 Hz then you would simply zero out all S[ ] elements EXCEPT 6. You have now implemented a very narrow filter.

Or consider that you might want to notch out a 24 Hz carrier which is giving you trouble. Then you would simply set S[24] element to zero. In C you would write "S[24]=0;." Done.

For simple filters we need only need to scale each of the S[ ] array elements. When doing just this scaling, we can think of each S[i] having an associated weight or W[i]. Then we design our filter by assigning values to W[i]. To process S[ ] we simply say:

```
for (i=0;i<100;i=i+1)
  Sp[i] = S[i] * W[i];    //compute a new array called Sp[ ]
```

We would do this so that a program could write the values of W[ ] when the filter parameters changed. Then scaling S[ ] using W[ ] could be done very quickly.

There are many more advanced things you can do with the S[ ] array. I mention a few here just to pique your interest:

- You can convert frequencies. If you'd like to move the signal at 24 Hz down to 6 Hz you could simply write "S[6] = S[24];".
- You can listen to two frequencies at the same time by ADDING the Spectrum elements together. To listen to 6 Hz and 24 Hz translated down to 6 Hz you just write "S[6] = S[6] + S[24];".
- Notice that W[ ] is essentially a graphic equalizer.
- You can see how the typical spectrum display on commercial rigs is easily implemented using the S[ ] array. And the waterfall display is simply a different display program of the S[ ] array.
- You can implement "automatic fine tuning" by examining the S[ ] array and adjusting the frequency to make a chosen frequency S[chosen] the maximum.

Now, yes, I've simplified things a bit, but you can see the possibilities. There are lots of refinements to be made in any DSP approach I'll describe here. These refinements can make tremendous improvements, but they are only refinements. Once you get the basic stuff you will have the context to read the literature and understand all the refinements. Warning: "refining" can become addictive.

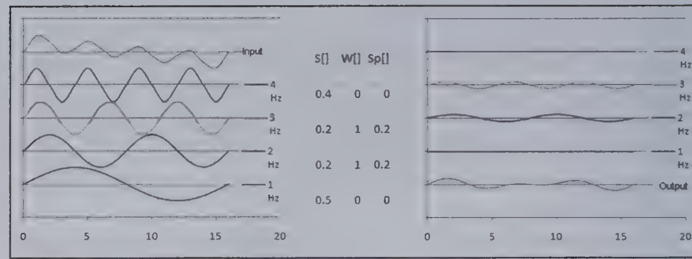

Figure 1—Overview of the software filtering process.

OK. So once we process the S[ ] array as needed we have a new array called Sp[ ]. We can't send Sp[ ] out to the headphones or speakers because the CODEC doesn't understand frequencies, it wants time samples. So we need to convert the Sp[ ] array back into a bunch of CODEC samples. This is done by using the "inverse Discrete Fourier Transform" or IDFT. Let's call the output of the IDFT the N[ ] array.

Now don't think of the IDFT as anything magical either. Think about an individual element in Sp[i]. If Sp[i] is big (say 1) then there the signal contains a lot of the frequency associated with Sp[i]. This means that N[ ] should contain a sine wave of frequency i Hz. If Sp[i] is small then N[ ] should contain a small amount of the associated sine wave. Remember, we had a way to describe this sine wave array: B(iHz)[ ]. This means that N[ ] is the sum of all the sine waves B(i)[ ] weighted by S[i]. In reality, each element N[j] is the convolution of S[i]xB(i)[j]. Look closely at that equation and try to decipher it. Said differently, "The IDFT is just the weighted sum of a bunch of sine waves."

Figure 1 shows the whole process from I[ ] to N[ ]. It is a little involved. On the left I show an input signal I[ ] at the top and four sine waves below it. Each one of these sine waves is correlated to the input generating the 4 element vertical array S[ ]. I then multiply each S[i] with the associated W[i] to implement the filter. Here I decided to implement a band pass filter which would pass just 2 Hz and 3 Hz. Having created Sp[ ] I then show the weighted sign waves on the right. Note that the top and bottom reference sine waves are straight lines; I filtered them out, remember? Then I add those sine waves together to get N[ ].

Now we have a complete path:

1) Take in a bunch of CODEC samples to make I[ ]
2) Perform the DFT on I[ ] to make S[ ]
3) Process S[ ] by weighting it using W[ ] to generate Sp[ ]
4) Perform the IDFT on Sp[ ] to create N[ ]
5) Deliver N[ ] to the CODEC.

Once you are comfortable with all this out you can start scaling the frequencies. For example, we simplified things by sampling things at 100 Hz. If our sample rate is really 16000 Hz then the bandwidth represented by S[i] is really S[i*160]. More exactly, in general the frequency in any S[i] is really i*SampleRate/BlockSize.

And there is one more important fact I need to make. All along

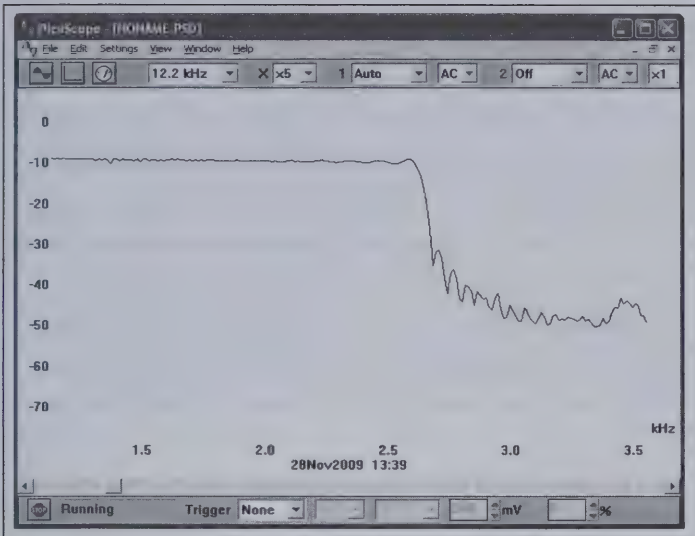

Figure 2—Filter passband with sidelobes.

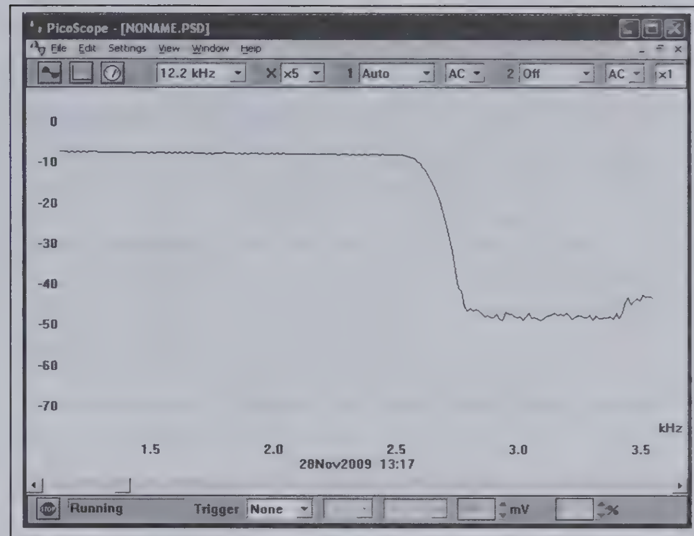

Figure 3—Filter passband after windowing is applied.

I've been writing about the Discrete Fourier Transform but most people don't talk about the DFT. Why is this? Well, if you use a block size which is a power of two then there is a really fast way to compute the DFT and it is called the Fast Fourier Transform (FFT). In general, the amount of time it takes to compute the DFT is MxN where M is the length of the correlations and N is the number of bins in the DFT. If M and N are the same size and a power of two then the FFT can compute the DFT in NlogN time. Please note though, the FFT is exactly equal to the DFT of the same data.

Wrapping Up the Fundamentals

So let's sum things up. Please remember that I'm talking informally here, all the nitty-gritty details are explained in countless publications. We're just trying to understand what is happening so we can read the books already knowing the lay of the land.

We started out thinking about how to compare an incoming signal to a reference signal and found that correlation could be used to make that comparison. Further, we saw how that comparison could be used to create a filter for a given frequency. Then we saw how a bunch of these single frequency correlation filters could be combined and a bandpass filter could be implemented. We saw that the computation of bandpass filters was no more time consuming than a filter for a single frequency because we could build a filter kernel we called F[ ] which produced any band pass we wanted.

Having understood how correlation could be used to compare signals we then turned to the Discrete Fourier Transform. We saw that the DFT was really just the result of performing a large number of correlations. The reference signals for the correlations are evenly spaced harmonics of sine and cosine waves. We called these correlations S[ ]. Having created all these S[i] elements we saw how they could be manipulated and that this manipulation was really taking place "in the frequency domain." Having processed S[ ] to create a new Sp[ ] we then saw how to convert our signal back into the "time domain" array N[ ] by summing up a bunch of weighted reference signals B(i)[ ] by using the IDFT.

A Weakness of the DFT (and Correlation as it turns out)

Up until this point all the signals we have been discussing have been selected to deliver "perfect" results. Specifically, I have chosen signals consisting of sine waves which were an even multiple of the sample period. In the DFT discussion we worked with signals that were 1 Hz, 2 Hz, 3 Hz, etc. But real world signals are not so cooperative. What happens when, say, we have a 1.25 Hz signal? Where does a 1.25 Hz signal appear in the DFT? One would hope that it would appear mostly in the 1 Hz bin and partly in the 2 Hz bin and this is mostly true; the biggest values in S[] will be in 1 Hz and 2 Hz.

Unfortunately, the complete answer is that the 1.25 Hz signal will appear, to some extent, in ALL the DFT bins. This phenomenon is called "Spectral Leakage" and is covered at length in countless publications. I have tried to find an intuitive explanation of this phenomenon but have yet to find one I like. I'll describe my best present thinking. Before looking at the solution though, let's look at the problem. Figure 2 shows what happens when I design a filter ignoring the spectral leakage problem. Examine the area around the upper frequency roll-off. Not very good, right? There are ripples in the pass band and side lobes in the stop band.

One way I've come to think about these ripples and side lobes is to consider them as simply "ringing" except here the ringing is in the "frequency domain." Consider the array W[ ] we used to scale the S[ ] array in the Spectrum. For a low pass filter, this array is a series of 1s followed by a series of zeros. If you think of this as a normal signal and run it through a circuit, you would expect some ringing as a result of the very fast falling edge. This ringing is what we are seeing in the side lobes in Figure 2!

One way to eliminate ringing on signals is to low pass filter them. Indeed, if I simply low pass filter W[ ] the side lobes will be significantly reduced. Of course, when I low pass filter W[ ] I expect the edges of the frequency response to slow down as well. In other words, I expect the roll-off to be less steep. All this can be seen in Figure 3.

The filtering of W[ ] is called Windowing and is the subject of endless debates if not downright arguments. There are many different window functions and each one has advantages and disad-

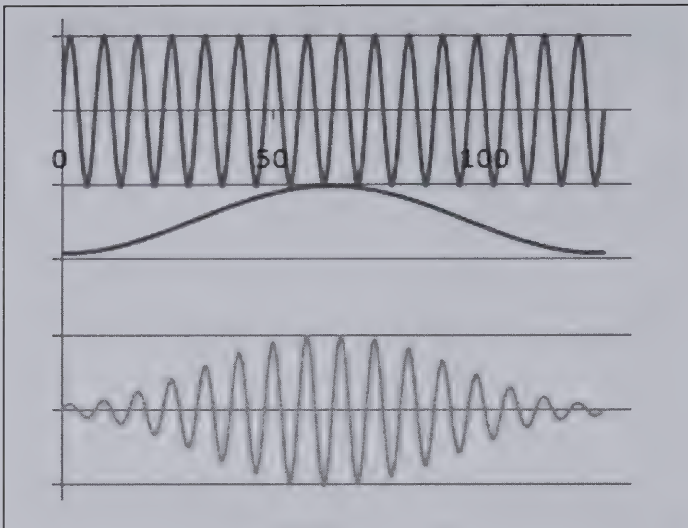

Figure 4—The Hamming window function.

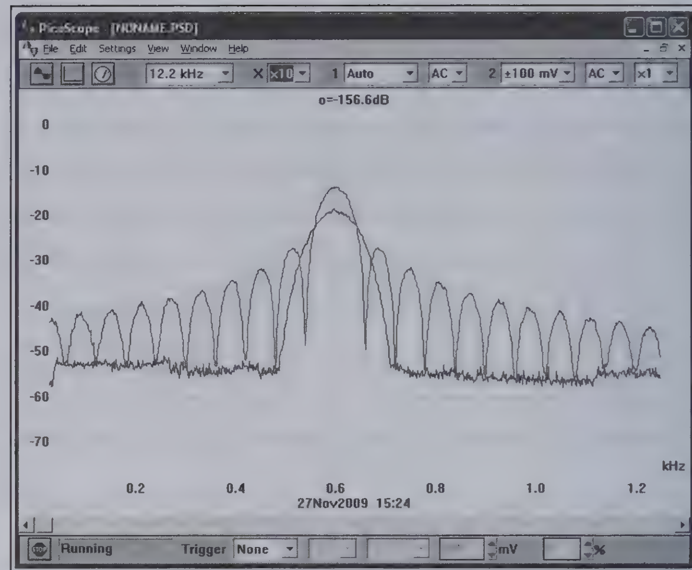

Figure 5—Comparable filters with and without windowing.

vantages. There is a general trend, though. The less you filter W[ ] the faster the roll-off will be and the larger the side lobes will be. On the other hand, the more you filter W[ ] the slower the roll-off and the smaller the side lobes. For general-purpose use I use what is called the "Hamming" window. How do I apply this window?

Well, as it turns out, most window functions are not applied to the W[ ] array at all. Rather, they are applied to the F[ ] array being used for the correlation filter. This is simply a matter of convenience, after all, there is no real difference between the F[ ] array and the W[ ] array. Indeed, later we'll see how to convert between the two. OK, so the windowing is done in the F[ ] array. Just how? Well, in the case of the Hamming window the F[ ] array is multiplied by $(0.54\text{-}0.46\cos(x))$. Figure 4 shows this graphically for a single frequency filter. Notice how the values of the final F[ ] array (shown at the bottom) start small, grow and then shrink again.

Figure 5 compares two filters, one with the Hamming filter and one without. Both filters are exactly 1 DFT bin wide. The wide trace with no significant side lobes is a single bin with the Hamming window applied. The taller and narrower trace is an unwindowed version of the filter. Notice the roll off is faster but the side lobes are much larger in the unwindowed case.

Let me close this section with a couple of remarks. In this description of correlation and DFTs, I have glossed over many details some of which are critical. My goal was not to provide a cookbook of how to use correlation and the DFT/IDFT pair. Rather, I hope I have shown you that these technologies are not mystical and can be understood intuitively with only a little guidance. I hope that I have laid a foundation of understanding that gets you over the initial hurdle of using this powerful technology.

Now let's explore a few of the fundamental digital signal processing techniques used in my SDR. It is time to show how some of this stuff gets used in my SDR. Here are a few notes on various problems I encountered and how I solved them.

The ejm Function

One of the very first subroutines I had to write was a fast version of "sin" and "cos." The dsPIC C library provides these functions but they are designed as general purpose and precise functions which return high precision numbers. These subroutines take hundreds of microseconds or even milliseconds to complete; much too long for real time DSP operation.

There are several ways to implement fast versions of these functions with varying precision/speed tradeoffs. I ended up choosing a simple table lookup scheme. My table is 1024 entries long and does interpolation between the points. I call my subroutine "ejm." "ejm" takes a single Fractional argument which is the angle and returns a Complex number. The precise code is a straight forward exercise in programming and not shown here. The following code is shown for clarification. (Take Note: This is NOT functional code, I have left out details concerning the translation of Fractional to C language "floats.")

```
// function taking one Fractional
// and returning Complex

Complex ejm(Fractional angle)
  {
      Complex rval;
      rval.i = cos(PI*angle);
      rval.q = –sin(PI*angle);
      return(rval);
  }
```

Note that because the "angle" argument is a Fractional it can have values from (essentially) –1 through 1. Note also that this means that we don't need to worry about the angle ever being outside the range of –PI to PI. This eliminates any bounds checking which might need to be performed.

This routine is used extensively throughout my code whenever a sine or cosine wave is needed.

The Hilbert Transform

I chose to implement the Hilbert Transform using an FIR-like construct. (FIRs are a method of implementing filters which, for

the purposes of this discussion, need not be further described.) Indeed, the only difference between a typical FIR filter and the Hilbert Transform is the coefficients in the F[ ] array. The coefficients in the F[ ] array can be computed using the IDFT or they can be computed in a closed form. I chose to compute the Hilbert Transform coefficients using the equations found in EMFRD.

There are other ways to generate the Hilbert Transform. A literature search is worthwhile. There doesn't seem to be any one way which is significantly better than all the others so I didn't pursue their implementation.

As with normal FIR filters the Hilbert Transform benefits from a windowing function applied to the F[ ] array. I use the Blackman-Harris window when implementing the Hilbert Transform.

General Purpose Filters

In the present incarnation of my SDR, I use correlation to implement my general purpose filtering. To do so, I generate my F[ ] array on the fly. I provide for three parameters in my user interface: lower cut-off frequency, upper cut-off frequency, and "filter length." To generate my F[ ] array I use a technique called "Windowed Sync." The code was taken almost literally from Reference 3. The algorithm is not very interesting but it is very instructive to play with each of the parameters.

Of particular interest is the "filter length" parameter. As discussed above, better filters require longer block lengths. As one shortens the F[ ] length the edges of the filter will get slower and the stop band attenuation will get worse. Conversely, as one increases the length the edges get steeper and the stop band attenuation gets better…. up to a point. In my SDR I found that when increasing the block length past 250 points, my filters simply did not improve. I'll return to this topic shortly.

There is little doubt that there are algorithms that produce "better" filters than the simple Windowed Sync—better in terms of roll off, ripple, stop band attenuation, FIR filter length, etc. However, the basic Windowed Sync produces very good results, is easy to implement and provides a transparent technology suitable for experimentation.

Narrow Filters

In researching the topic of filtering, I came to understand why my longer FIR filters did not produce better results. When doing very long convolution, the F[ ] array element values get quite small. I found this by looking closely at the F[ ] array values and then the algorithm itself. The center of the algorithm in Reference 3 is an equation which has the form sin(ki)/i where i is the index in the F[ ] array. This means that as the F[ ] array gets larger the i gets larger and the "/i" piece of the equation gets me in trouble.

An additional piece of the puzzle comes from the windowing function. Essentially all windowing functions will have this problem; it is not peculiar to mine. The key point of the windowing function is the term that looks like "1–cos(x)" so when x is getting close to the ends of the F[ ] array, the "1–cos( )" term gets very close to zero.

The combination of these two features makes the F[ ] array vanish below 16 bit resolution. I thought long and hard about how to get around this problem. Ultimately, I found a technology called "Sliding DFT" with frequency domain windowing. As it turns out, I did not implement the Sliding DFT exactly. I have seen my modification called the "Running DFT," a term that is a little less formal so I'll go with that name. Let's start with how to implement the Running DFT.

The Running DFT allows me to compute the value of any single bin in the DFT one CODEC sample at a time. As with the filters we've discussed earlier, the basic technique is essentially a running correlation of the incoming data with a reference signal. The first step is to implement the reference signal. Let's continue our discussion assuming I would like to correlate 1024 samples of the incoming signal.

Before delving into the code there are a couple of important concepts that need pointing out. First, I need to avoid working with small numbers whenever possible and I certainly don't want to do any division (too time consuming). Second, I want the calculation to be "stable." It is very important that intermediate numbers not grow. As a result, I need to worry about when precision is being lost. Now, on with the discussion…

Remember that the correlation is the sum of the product of the incoming signal and the reference signal. Each time a new CODEC sample arrives I need to compute the product and add it to the sum. In addition, I need to subtract out the contribution of the 1024th oldest input. For this discussion I use a ring to keep the 1024 entries; I won't show the ring code again.

In order to allow me to write more concise programs (and therefore programs with fewer bugs) I'm going to keep the "sums" as BigComplex numbers; see the declaration below. Note that I already introduced two functions for manipulating Complex numbers: CxC to multiply and CpC to add. These were necessary because C does not have a "native" Complex number type. For the purposes of the code below, however, I'm going to use * and + to indicate multiplication and addition. The real code would need to use CxC and CpC.

Here is the basic code for implementing a Sliding DFT for bin number "i":

```
typedef struct {long i; long q;} BigComplex;
BigComplex aSumi;
Complex tempC;

oldestI = inputRing[ringIndex];
inputRing[ringIndex] = I;

tempC = ejm(i*ringIndex/1024);
aSumi = aSumi + tempC * I;            //correlate and add
                                        in new.
aSumi = aSumi - tempC * oldestI;      //take out old.
```

There are a couple of important details I slipped into the above code. First, the reference signals make complete and exact cycles every 1024 samples. The inputRing also cycles every 1024 cycles. Thus, I guarantee that the reference signals have EXACTLY the same value when a CODEC sample is "added in" and when it is "subtracted out" 1024 cycles later. Second, the running sums are 32 bits long so there is no chance of an overflow. The maximum value which might be in "aSum"is only 512. Third, notice that I add in and subtract out values directly to the sum. This is because when using Fractionals there is no absolute assurance that

"a(b+c)" is exactly the same as "ab + ac." Rounding can make a difference.

Believe it or not, that is all one needs to compute the running DFT. However, we still need to apply a windowing function or there will be significant side lobes. Let's explore how to apply a window in the frequency domain using the Hamming Window as an example. Remember that the Hamming Window equation was $0.54–0.46\cos(x)$.

This Hamming Window equation is written "in the time domain," and we want to perform the windowing function "in the frequency domain." How do we convert from "time" to "frequency"? Yep, we apply the DFT to the equation $0.54-0.46\cos(x)$ window. A little bit of examination of the equation is quite telling. The first term of the equation is 0.54. This represents a DC value and we would expect the DFT of this equation to have a first bin S[ ] equal to 0.54. Second, the "cos" part cycles exactly once during the window and so we would expect the second bin s[1] to be of value 0.46. Well, we are half right. As it turns out, the DFT of the Hamming window has exactly 3 non-zero bins. S[0] is 0.54 as we expect but the .46 part is divided equally between the S[1] and S[-1] bins; each is –0.23. Generally speaking, real cosine signals always have spectra which are symmetric around 0. This is something you'll see repeatedly.

Now don't get flustered by that "-1," it is just math and it will go away in just a moment. We need to shift this window function up to the filter frequency of interest, here bin "i." The final W[] array will have three nonzero bins: W[i–1]=–0.23, W[i]=0.54 and W[i+1] is –0.23. Done. We've applied the Hamming Window to our single bin DFT. Unfortunately, this means we need to compute the running DFT of three bins rather than just one but that is a simple extension of the above code.

We have now computed the Sp[i-1],Sp[i] & Sp[i+1] bins but we aren't done, we need to compute the running IDFT. Fortunately, this is pretty easy too. To compute the running IDFT of a single bin we need to simply multiply the Sp[i] bins by the appropriate reference signals. I will again use * and + so as to improve readability, but the real code would need to use CxC and CpC as before. Also, please take note that the angle arguments to ejm are negated; the IDFT reference signals run in the reverse direction of the DFT references.

```
N =  –0.23 * ejm(–(i–1)*ringIndex/1024);
N = N + 0.54 * ejm(–i*ringIndex/1024);
N = N – 0.23 * ejm(–(i+1)*ringIndex/1024);
```

The final step is to scale the final value N so that it isn't too big. It turns out that any single DFT bin can reach the value equal to the length. In this case that is 1024. Thus, the final N above can be as large as 1024 (1024*0.54 + 1024*0.46). Fortunately, this is a power of two and a simple shift wraps up the computation. N can now be handed to the CODEC for output.

The running DFT allows you to build very tight filters without doing any division (well, almost) and without losing any precision. If one makes a few optimizations the above code can run VERY fast. The key optimization is to replace a call to ejm with a direct table lookup. This is possible because it turns out that there is no need for interpolation if the table is large enough. Other optimizations are performed in the final version of the code but these optimizations tend to make the code less readable and so are not shown here.

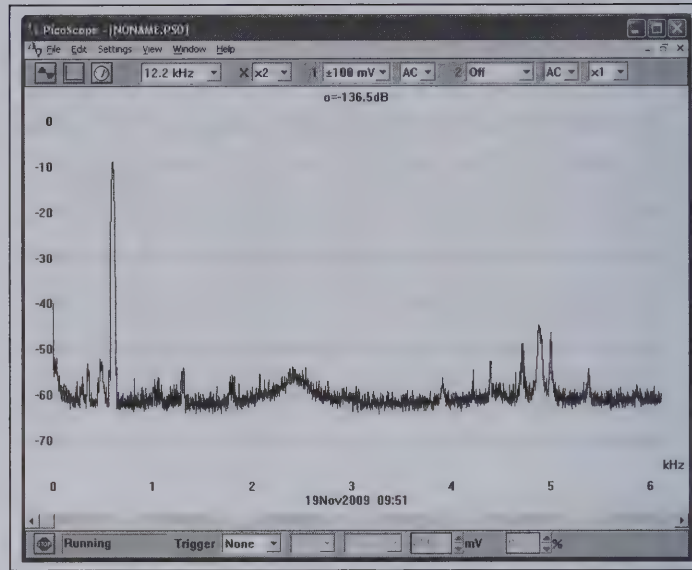

Figure 6—A 600 Hz filter using the sliding DFT process.

Figure 6 shows a filter for 600 Hz using the Sliding DFT. This filter rolls off over 43 dB in just 50 Hz. Using a slightly more aggressive Window (Blackman-Harris) this roll-off can be 73 dB in the same 50 Hz!

One final note: if you were particularly observant you would have noticed that this filter uses a complex input I. When this is done then the Running DFT does sideband selection in addition to filtering. Thus, when using the Running DFT as a filter as I do here, there is no need for the Hilbert Transform.

Arbitrary Filters

We spoke at length about how to implement arbitrary filters using both the DFT and correlation. It was fairly simple to see how to implement funky filters in the DFT, we simply had to scale each element of the S[ ] array. Remember that we used a second array W[ ] to express these scale factors. Then we would perform a DFT, scale the spectrum using W[ ] and then perform an IDFT. So designing our filter in the frequency domain was pretty easy: just assign the appropriate values to W[ ].

However, in discussing correlation I conveniently glossed over how to create an arbitrary filter array F[ ]. As it turns out, you already have all the tools necessary. Remember that we wanted to create F[ ] by adding a bunch of reference signals together? Well, that is exactly what the IDFT does, right? So to create F[ ] we simply perform the IDFT of the W[ ] array and, *voila*, an F[ ] suitable for use in Convolution! But don't forget to apply a window!

There are, of course, many other ways to generate the F[ ] array. Some of these methods generate better results; faster edges, shorter F[ ] arrays, flatter pass bands or deeper stop bands. Most of these tools cost money and are largely opaque. A professional engineer would benefit from their use. The vast majority of hobbyists will find this simple approach more than adequate.

Using the FFT in the Data Path

Think back about the description of the DFT and IDFT. In that

section I described a way to perform filtering completely in the frequency domain. The basic approach was described as I[ ] –> DFT –> S[ ] –> IDFT –> N[ ]; input converted to spectrum, processed and then converted back to output. This approach to signal processing is called "Fast Convolution" and there are some complications involved. A little research is in order if you are interested.

I have tried numerous times to make this work and have failed each and every time. I have coded the approach independently several times using several different algorithms and always failed to achieve acceptable performance; specifically, every attempt has produced a low frequency "beat" tone that was related to the size of the input ring. I have tried to understand why this has not worked and would appreciate any insight anyone might offer.

My best understanding of this problem right now is that 16 bit, fixed point arithmetic simply loses too much precision during the calculation of the FFT and IFFT. I am still intrigued by this approach and keep trying. The next effort will be to code up my own highly optimized version of the FFT and see what happens when I increase the precision of the arithmetic.

I would point out that I don't believe that there is really that much to be gained by using this approach in my radio. For basic filters either correlation or the Running DFT can perform adequately and are much easier to program and maintain.

Summary

With this portion of my article, I have completed the description of the SDR's CW and SSB receiver. I have not worked on a SSB exciter as my Class E power amplifier will not support SSB.

My Software Defined Radio project has been and continues to be a grand adventure. It has afforded me countless hours of education, entertainment, distraction, frustration and excitement… and I treasure every minute. In this series of articles, I have discussed a variety of obstacles I have encountered and solutions I have employed. Most of these obstacles were typical problems with typical solutions. When a problem was familiar I endeavored to use the "standard" solution. Other problems were new to me and required significant research before the problem was totally understood and a solution was selected.

My entire design database; schematics, pc board layout, parts list and software will be provided on the *QRP Quarterly* Web site as well as my own which is www.ae6ty.com. This will allow you to see exactly how I solved (or ignored or overlooked) a problem.

Through this article, I hope I have piqued your interest in building and perhaps even designing your own equipment. At the very least, I hope I have given you a glimpse of some of the techniques and capabilities of the emerging technology called Software Defined Radio.

In the next issue of *QRP Quarterly* we'll shift gears to a more hardware oriented portion of the project; the output power amplifier. That article, Part IV of the series, will explore the design methodology and computer tools used to implement a single band, 5 watt, class E amplifier.

—73/72, Ward, AE6TY

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2. Hayward, Campbell, Larkin, *Experimental Methods in RF Design*, The American Radio Relay League, 2003
3. Smith, Steven W., *Digital Signal Processing A Practical Guide for Engineers and Scientists*, Newnes, 2003

One More Note from WA8MCQ's Idea Exchange...

Cleaning Up NiCd Battery Leakage

Gary McCaughey, W2UX posted this on qrp-l@qth.net—

A nice StreamLite flash light with a nickel cadmium (NiCd) battery stick inside was just given to me. I opened it and there is white dust from the battery inside. You can see a spot where there is some sort of corrosion. What can you use to clean this stuff? It is not like a lead acid battery that you can clean up with baking soda. Also, this stuff is considered toxic, right?

This reply came from Brad Thompson, AA1IP—

If I recall correctly, the white residue is sodium hydroxide electrolyte (an alkali or base), which you can remove with a discarded toothbrush or a cotton swab dipped in a weak acid such as vinegar. Once the residue is removed, swab the area with distilled water (or tap water) to remove any chemical residue and allow it to dry. Inspect for damage—if the battery contact region isn't too badly damaged, use as is. Otherwise, you may have to improvise a replacement contact.

DE WA8MCQ—

I checked Wikipedia, the online encyclopedia, and it indicated that the electrolyte is potassium hydroxide (KOH). Some other web sites indicated the same thing. To be safe I decided to check the web site of Saft, a company that actually makes this sort of thing. (Not exactly a household term in this country, it's a large French company that has been around for a very long time.) It says, "Nickel-cadmium cells have an anode (negative) in cadmium hydroxide and a cathode (positive) in nickel hydroxide, immersed in an alkaline solution (electrolyte) comprising potassium, sodium and lithium hydroxides."

I've had good luck cleaning up NiCd residue with vinegar, as Brad suggests. It also works well if you have a leaking alkaline battery. If you have a battery leakage situation and can't tell what type it was (such as someone handing you a device with the leaking batteries already gone), try both vinegar and a bit of baking soda in water. One or the other should take it right off.

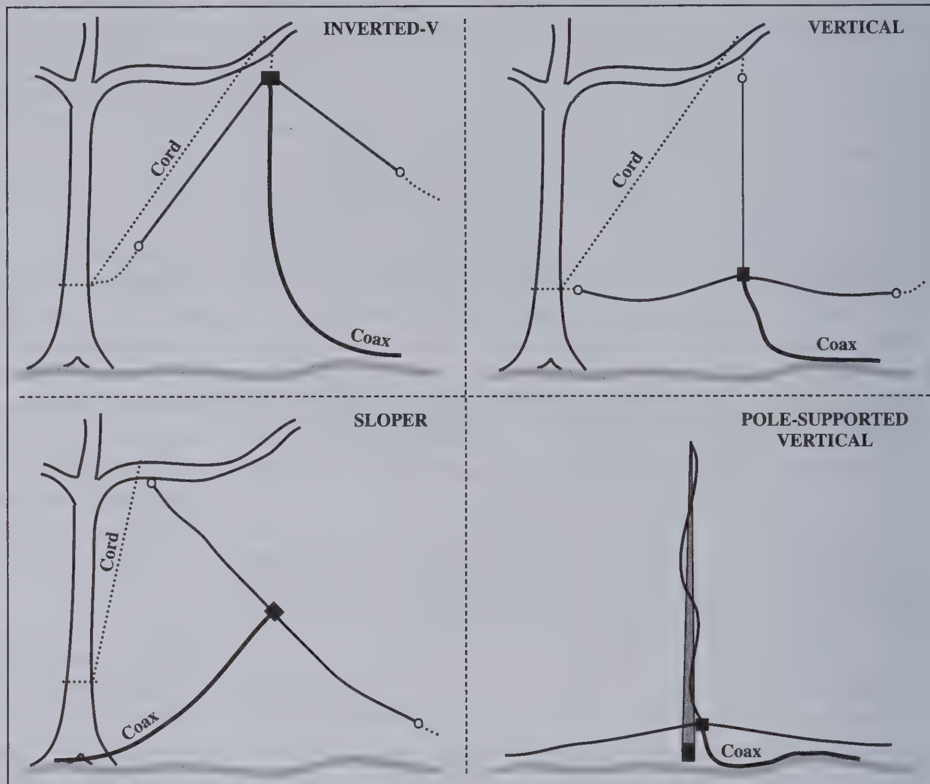
Antennas 101: My Favorite Portable Antenna

Gary Breed—K9AY k9ay@k9ay.com

In this issue, I decided to keep things really simple. With Field Day just finished and months of good weather ahead for outdoor operating, portable antennas seems like a good topic!

Most of my portable operating has been on 20M, using any of several different homebrew rigs. Because some of my past portable adventures were backpacking, light weight is essential. I've operated above tree line and in desert scrub, so some kind of support is needed as well. Here is the package that fills my requirements:

- Three (3) 17-foot lengths of #20 Teflon® insulated hookup wire with terminal lugs on each end. The slippery PTFE insulation minimizes abrasion, tangling and kinking.
- 50 or 60 ft. of nylon twine, like builders use. I like the visibility of bright pink or yellow line. I divide it into lengths as needed.
- Approx. 20-foot length of RG58/C (stranded center conductor) with a BNC connector on one end and a small plastic insulator with two screw terminals on the other end, which is the antenna connection.
- When needed: a 3-meter (20 ft.) telescoping fishing pole. Most recently, this has been the SD-20, a graphite composite pole. As a bonus, putting a rubber crutch tip on one end lets the pole double as a walking stick.



There are several ways to install a simple vertical or dipole in the field.

Vertical, Horizontal or Sloping?

First, there is a reason for having three lengths of wire—so I can install a vertical with two radials as well as a dipole. When there are trees available, an inverted-V, semi-straight, or sloping dipole is the usual installation. Sometimes, though, it is easiest to get the cord over a fairly high tree limb and install the antenna as a vertical.

With no trees, I almost always use the telescoping pole to support a vertical with two radials. (I could use an inverted-Vee, but it's a lot more complicated with the extra weight at the top of the pole.) Since the pole is 20 feet long, the feedpoint is a few feet above ground, and I try to lay the radials on top of vegetation to get them above ground—in theory, any extra distance above the lossy earth will improve the vertical's efficiency.

In the field, however, theoretical performance is rarely the most important issue. Practical matters are far more important, such as getting to a site and asking, "Where can I put this thing...?" To be honest, I have not been able to discern any difference in the ability to make QSOs among all the possible installation methods (see figure above). They all seem to work quite well. Ultimately, the geography of the site is the dominant factor—a scenic ridgetop is great, a deep valley is not!

Is Bigger Really Better?

If you are car camping, operating from a vacation cabin, or just setting up at someone else's home, you might justify a bigger installation. But even then, practical matters are key, especially the available method of supporting the antenna. Better performance nearly always involves getting the antenna higher—and if there are no good-sized trees, you need to provide some kind of tall support.

I've discovered that such ambitious plans for a great portable operation can end up being a LOT of work—and might not work as well as you expected.

Twice in the past, I hauled masts and a small triband beam to mountain ridge locations for a contest weekend. The first time, I was so tired after wrestling everything into place that my contest effort suffered! The next time, the chosen site had too many trees in the way of the beam. So I got a rope over a high limb (45 ft. or so) and hoisted just the driven element and used it as a triband dipole. It worked great, and all that other hardware was never used.

Since then, my portable antennas are always simple: dipoles and verticals. And I try to plan those operations in places where there are trees that can provide natural "towers." With no trees, I lower my expectations (pun intended) and use the telescoping pole—although I might add some extra aluminum tubing at the base to get at least a little more height!

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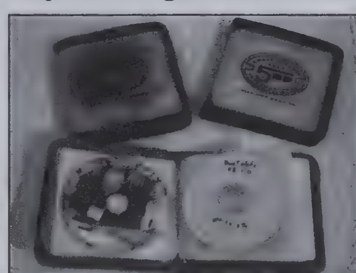

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QRP Contests

Jeff Hetherington—VA3JFF

contest@qrparci.org

We have made it through the Winter Blues, and successfully past the newness of Spring. Some of us made the pilgrimage to Dayton for the Hamvention and of course Four Days in May, and have now returned home recharged with ham radio energy to make it through another year. Spring newness is something that is rather interesting, as it happens every year. Every spring the grass once again begins to grow, trees sprout new leaves, bud begin to appear on the rose bushes and flowers begin to bloom.

Our Spring QSO Party also runs at the beginning of every April, and curiously enough there is always a group of new contesters that enter our realm. Many new callsigns are heard on the air, and several stations comment about the fact that the Spring QSO Party was the first contest, or first QRP contest that they have entered. This is of course great news to us as it gives the regular contesters new people to contact, but it also allows us to continue to grow our numbers and provides us a solid base for years of contesting ahead.

With that said, I would like to welcome Rene Correa—K5JX, Clark Macaulay—KE4RQ, Marcia Stockton—K6MEE, Bill Crosier—NT9K, and Fred Belghaus—W2AAB. These five operators all indicated on their entries this quarter that it was their first time in a QRP-ARCI contest, and we are glad that they came out to join with us. Hopefully we will hear you on the air in the future events. I would like to challenge each of the regular contesters in our group to talk up the QRP-ARCI contests to your friends and colleagues.

You all know how much fun they are, you are there every time the contests run. Are you members of a High-Powered contesting group? Talk to them about getting on the air, testing equipment before the "big" contests, put out a personal challenge to the top score for your group, let them know there is a certificate for the top scoring QRO station or perhaps put in a team in the coming Fall QSO Party.

2010 QRP-ARCI Contest Schedule

16 - 17 October 2010 — Fall QSO Party

2 December 2010 — Top Band Sprint

19 December 2010 — Holiday Spirits Homebrew Sprint

Mark Your Calendars!

Can you imagine how much more fun it would be if there were twice as many stations on the air for our contests? Word of mouth is our best advertising, please spread the word and bring one other operator along with you for the next event. All it will take to double our numbers is for each one of us to bring a friend.

The Grid Square Contest is continuing to prove to be one of the favourites among the QRP-ARCI crowd. Many stations comment about the fact that it is nice to not have to copy to same old predictable exchange, and that the operators really have to pay attention to copy the grid square. Most of all, it is nice to be able to look at the grid square map and quickly get an idea of how far your signal has travelled.

When all the excitement on the bands died down, Bob Patten—N4BP was able to successfully defend his 2009 win and took home top honours with 62,440 points. Randy Foltz—K7TQ finished second with 48,944 points while Sean Kutzko—KX9X operated from the ARRL Employee Club Station W1HQ for a third place finish with 31,080 points. A close battle rounded out the top five with Tim Colbert—K3HX taking fourth place with 13,860 points ahead of Paul Beringer—NG7Z who totaled 12,600 points while Barry Ives—AI2T and Arnold Olean—KØZK both totaled more than 12,000 points but just missed the top five.

The 2010 Spring QSO Party saw a repeat of 2009's fight for top spot between Willie Baber—WJ9B and Bob Patten—N4BP. This time N4BP took first place with an amazing total of 1,734,544 points. In this high scoring battle in Florida, WJ9B was relegated to a second place finish with 585,746 points.

Guy Hamblin—N7UN took third place with 339,304 points while Paul Kirley—W8TM scored 274,456 points for fourth place and Paul Beringer—NG7Z scored 230,153 points for fifth spot. Rounding out the top ten were Jim Stafford—W4QO with 205,485 points, Hank Kohl—K8DD with 198,653 points, John Thompson—K3MD with 167,440 points, David C. Moses—WØPQ with 161,210 points and Tim Colbert—K3HX with 154,938 points. Chris Brakhage—WB5FKC was the top scoring less than one watt entrant with 45,240 points, and Bill Crosier—NT9K scored 7,040 points with less than 50 milliwatts to win that division. David Scranton—W9WE could only get the power down to eight watts as he doesn't have any QRP equipment, but he made it work for 416 points and the greater than five watt category certificate.

The team competition saw MONTeam of Jorge R. Daglio Accunzi—EA2LU and Jose A. Gurutzarri—EA2IF combine for 193,760 points while the QRP-ARCI Staffers team of Jim Stafford—W4QO, Hank Kohl—K8DD, Bill Kelsey—N8ET and Jeff Hetherington—VA3JFF scored 732,788 points to take the team award. This was the first contest to feature a multi-operator category, but there were no entrants.

Until next time, keep your power down and your QSO rates up.

—73/72, Jeff, VA3JFF

Grid Square Sprint Soapbox

Too far from population centres for 40m to be any use daytime, and no prop on 15m or 10m makes for a single-band 20m entry. —N4BP

Best conditions in a long time, and a reasonable turnout —K7TQ

The weather was cold, rainy and windy, so outdoor operating was a bad idea. I had fun handing out FN31 from the ARRL Employee Club Station W1HQ instead. Will hope for better weather next

2010 QRP ARCI Grid Square Sprint Results											
NAME	**Call**	**S-P-C**	**ARCI#**	**Bands**	**POWER**	**Qs**	**Pts**	**Grids**	**Mult**	**Bonus**	**SCORE**
Bob Patten	N4BP	FL	3412	20	< 5W	50	223	40	7	0	62440
Randy Foltz	K7TQ	ID	8336	15/20	< 5W	42	184	38	7	0	48944
Sean Kutzko	KX9X	CT		20/40	< 5W	35	148	30	7	0	31080
Tim Colbert	K3HX	PA	5415	20/40	< 5W	24	99	20	7	0	13860
Paul Beringer	NG7Z	WA	11300	15/20	< 5W	21	90	20	7	0	12600
Barry Ives	AI2T	NY	5136	20/40	< 5W	17	67	16	7	5000	12504
Arnold Olean	KØZK	ME	10099	15/20	< 5W	15	68	15	7	5000	12140
Jim Wilson	VE3MO	ON	6607	20/40	< 5W	19	71	14	7	5000	11958
Andrew Measday	WA5RML	TX	12067	15/20	< 5W	15	60	15	7	5000	11300
Rob Schweitzer	KØCD	WI		20	< 1W	16	70	16	10	0	11200
Bill Cunningham	K4KSR	VA	12712	20/40	< 5W	19	86	16	7	0	9632
Ken Newman	N2CQ	NJ	7975	20	< 5W	18	74	16	7	0	8288
Ed Tobias	KR3E	MD	85	ALL	< 5W	16	73	15	7	0	7665
Mert Nellis	WØUFO	MN	9720	20/40	< 5W	15	69	14	7	0	6762
Dennis Bullock	N6DIT	CA	12871	15/20	< 5W	15	67	13	7	0	6097
Steve Whitton	K9IS	WI	10711	ALL	< 5W	14	63	13	7	0	5733
Larry Mergen	KØLWV	MO	8357	20/40	< 5W	13	59	13	7	0	5369
Robert MacKenzie	VA3RKM	ON	12259	ALL	< 5W	13	56	11	7	0	4312
Jaroslav Kolinsky	OK1MKX	*OK*		80	< 1W	16	32	12	10	0	3840
Chris Brakhage	WB5FKC	TX	3571	20	< 1W	8	40	8	10	0	3200
Fred W. Belghaus	W2AAB	NJ	13635	20	< 5W	9	41	9	7	0	2583
Richard Glassner	NØEAX	MO	10726	ALL	< 5W	7	32	7	7	0	1568
Edwin "Ted" Albert	AB8FJ	OH	8544	ALL	< 5W	6	30	5	7	0	1050
Jim Anderson	NV9X	IL	8175	20	< 5W	4	17	4	7	0	476
Jeff Hetherington	VX3JFF	ON	9223	20	< 5W	3	15	3	7	0	315
Andy MacAllister	W5ACM	TX	11933	15/20	< 5W						Checklog

Top 5 Grid Square Sprint

Bob Patten—N4BP	62,440 pts
Randy Foltz—K7TQ	48,944 pts
Sean Kutzko—KX9X	31,080 pts
Tim Colbert—K3HX	13,860 pts
Paul Beringer—NG7Z	12,600 pts

time. Thanks for the QSOs! —KX9X

Low noise on 40m! —K3HX

Didn't have much time, but good to hear so much activity. Too bad more didn't get on 15m, it was open! —NG7Z

Portable in the attic with battery power and a temporary antenna strung around the room. —AI2T

Had lots of fun operating from Lake Arlington. Glad to see that 15m was open, but not much activity there. —WA5RML

I checked 15m many times but no action. It was fun working the regulars; hope for more activity next time. —WØUFO

Condx were good on 40 but no one there! Still happy to have the contest. —KØLWV.

Took time out from the Commonwealth Contest. —VA3RKM

Used Cimrman's PA with –10 dB gain. Jara da Cimrman is a mysterious Czech inventor and explorer who lived in the past and invented many curious (and unuseful) things. His activities will be on display at Shanghai EXPO 2010. —OK1MKX

This is my first effort in a QRP-ARCI contest. I was disappointed in the very low turnout, at least on 20m. Let's hope the sunspots will permit greater participation in future events. —W2AAB

I enjoyed the event. Operated on 80, 40, 20 & 15. No contacts on 80. Thanks to N6DIT for the 15m contact. —NØEAX

Conditions much better this year. Glad to work K7TQ on 15m. —AB8FJ

Got to hand out a special prefix for the Vancouver Winter Olympics to the participants. —VX3JFF

Lots of DX on 15m. Nice contacts on 20m. It was a beautiful day at Tom Bass Park III on the north side of Pearland. Operators included Ed N5EM, Fred WA5BUC and Andy W5ACM. —W5ACM

Spring QSO Party Soapbox

Did not spend as much time as I had hoped. Activity seemed a bit low when I was on. —N8ET

GP Home made with 7m long telescopic fishing rod and 8 radials on ground of some friend's house backyard. Unfortunately, the weather was horrible on Saturday afternoon-evening with lots of very heavy rain and hail showers, which created S9+ QRN, thus letting me totally deaf and unable to copy anything for several minutes. After some hours like that, I lost motivation and decided to dismantle everything and look for another future party. —EA2IF

Great condx, although a longer opening on 15m would have been a huge bonus. Many signals were well over S9 on all bands. My high noise level still made copy of some impossible. Hung in for 22 hours until time to pick up daughter. —N4BP

Where was everybody? Heard N4BP constantly but Qs were few and far between. But for my first ARCI contest, a lot of fun nevertheless. Guess the Easter weekend was a challenge to everyone's schedules. —N7UN

40m was very good this year. Worked 6 or 6 stations on both bands. —WØPQ

Always a great time. —K3HX

Glad so many took time out from the holiday to join in. The weak conditions on 20m made for a dull time, but the excitement of so many QRPers on 40m Saturday

2010 QRP ARCI Spring QSO Party Results										
NAME	Call	S-P-C	ARCI#	Bands	Power	Qs	Pts	SPC	Mult	SCORE
Bob Patten	N4BP	FL	3412	ALL	< 5W	452	1822	136	7	1734544
Willie Baber	WJ9B	FL	8953	ALL	< 5W	248	973	86	7	585746
Guy Hamblen	N7UN	NJ	7929	ALL	< 5W		664	73	7	339304
Paul Kirley	W8TM	OH	11960	ALL	< 5W	166	676	58	7	274456
Paul Beringer	NG7Z	WA	11300	ALL	< 5W	130	539	61	7	230153
Jim Stafford	W4QO	GA	6515	ALL	< 5W		515	57	7	205485
Hank Kohl	K8DD	MI	5731	ALL	< 5W	115	481	59	7	198653
John Thompson	K3MD	PA	1114	ALL	< 5W		460	52	7	167440
David C. Moses	WØPQ	NE	12642	20/40	< 5W	115	470	49	7	161210
Tim Colbert	K3HX	PA	5415	ALL	< 5W	106	434	51	7	154938
Charles Fulp Jr	K3WW	PA	545	ALL	< 5W	86	359	49	7	123137
Jim Lageson	KCØLIE	MN	6846	ALL	< 5W	79	329	50	7	115150
Robert MacKenzie	VA3RKM	ON	12259	ALL	< 5W		315	49	7	108045
Scott McMullen	W5ESE	TX	13124	ALL	< 5W	78	330	43	7	99330
Joe Vrabel	KD2JC	NJ	5787	ALL	< 5W		325	43	7	97825
Jorge R. Daglio Accunzi	EA2LU	*EA*	13578	15/20	< 5W	74	347	40	7	97160
John T. Laney III	K4BAI	GA	1208	ALL	< 5W	68	300	46	7	96600
Rick Arzadon	N8XI	MI	9050	20/40	< 5W	77	333	39	7	90909
Chris Haley	NB4M	TN		40	< 5W	130	407	31	7	88319
Steve Whitton	K9IS	WI	10711	ALL	< 5W		298	40	7	83440
John G. Parnell	K7HV	WA	13744	ALL	< 5W	70	302	39	7	82446
Dana "Mike" Michael	W3TS	PA	3315	ALL	< 5W	61	275	39	7	75075
Andrew Measday	WA5RML	TX	12067	ALL	< 5W		272	39	7	74256
Steve Galchutt	WGØAT	CO	4295	ALL	< 5W	70	302	33	7	69762
Steve Yates	AA5TB	TX	9101	20/40	< 5W		260	37	7	67340
Paul Beckett	KF7MD	CO	6817	20	< 5W	76	320	29	7	64960
Mark McLauchlin	KN7T	WA	13194	20/40	< 5W		262	35	7	64190
Bill Kelsey	N8ET	OH	7450	ALL	< 5W	63	269	34	7	64022
Mert Nellis	WØUFO	MN	9720	ALL	< 5W	50	266	34	7	63308
Dennis Bullock	N6DIT	CA	12871	ALL	< 5W	55	229	34	7	54502
Ed Dybowski	WD7Y	NV	9657	ALL	< 5W	56	223	34	7	53074
Jim Fitton	W1FMR	NH	4963	ALL	< 5W		204	33	7	47124
Chris Brakhage	WB5FKC	TX	3571	ALL	< 1W		174	26	10	45240
Barry Ives	AI2T	NY	5136	ALL	< 5W	47	208	29	7	42224
Rene Correa	K5JX	TX	13975	ALL	< 5W	42	180	33	7	41580
Kevin Clements	VE3RCN	ON		ALL	< 5W		179	30	7	37590
John McBee	KM5PS	AR	14013	20/40	< 5W	43	193	27	7	36477
Larry Mergen	KØLWV	MO	8357	ALL	< 5W	36	151	29	7	30653
David E. Reid	VA7DER	BC	4059	ALL	< 5W	39	174	25	7	30450
Al Britton	KIØJ	CO	12266	ALL	< 5W		161	26	7	29302

night was thrilling. And 80m was so quiet that I worked FL (N4BP), GA (K4BAI) and AL (AB9CA) all the way from Ottawa. Only DX were IK6FWJ and EA2LU (on 2 bands). —VA3RKM

Not enough time. Hope to participate more in the next contest. Thanks to all that participated. —KD2JC

Thanks to all who pulled me out of the constant racket (QRN) of local storms. Had fun and gave the K2 a workout which it hadn't seen in a while. —N8XI

I had fun despite poor condx. —K7HV

It was too nice outside to stay at the rig for long, so I operated in many small spurts. —W3TS

Top 10 Spring QSO Party	
Bob Patten—N4BP	1,734,544 pts
Willie Baber—WJ9B	585,746 pts
Guy Hamblen—N7UN	339,304 pts
Paul Kirley—W8TM	274,456 pts
Paul Beringer—NG7Z	230,153 pts
Jim Stafford—W4QO	205,485 pts
Hank Kohl—K8DD	198,653 pts
John Thompson—K3MD	167,440 pts
David C. Moses—WØPQ	161,210 pts
Tim Colbert—K3HX	154,938 pts

Another fun ARCI QSO Party. Bands were kind of flat, but still enjoyable. Very nice to work Arnie (CO2KK). Also nice to catch Jim (W1PID) and Mark (KO1U) on 15m. Worked Bob (N4BP) on 40-15m. Tnx for all the QSOs, see you in the Fall! —WA5RML

I had fun working my friends in the QSO party. I operated Saturday outdoors in my back yard with a solar powered MFJ-9020 at 4 W and a very low dipole in a tree. I managed to work KL5DX in Anchorage with that setup but he wasn't in the contest. Saturday night and Sunday morning I used my solar powered SW-40+ at 2 W on 40 m with my inverted-L EFHW antenna. The

2010 QRP ARCI Spring QSO Party Results (continued)

NAME	Call	S-P-C	ARCI#	Bands	Power	Qs	Pts	SPC	Mult	SCORE
Cranz L. Nichols	WB5BKL	TX		ALL	< 5W		172	21	7	25284
Will Bowser	K9FO	IL	5008	ALL	< 5W	37	157	23	7	25277
Steve Howard	ABØXE	MN	11423	20/40	< 5W	27	117	20	7	16380
Donald C. Younger	W2JEK	NJ	4631	Low Bands		< 5W	28	128	18	7 16128
Steve Ray	K4JPN	GA	1809	20/40	< 5W	24	111	20	7	15540
Clark Macaulay	KE4RQ	GA	10815	20/40	< 5W	23	114	16	7	12768
Curt Hulett	KB5JO	TX	12365	20	< 5W		115	15	7	12075
Philip L. Graitcer	W3HZZ	GA	13629	20/40	< 5W	26	121	14	7	11858
Jeff Hetherington	VA3JFF	ON	9223	ALL	< 5W	23	94	17	7	11186
Pat Byers	VE3EUR	ON	3447	ALL	< 5W	20	91	17	7	10829
Jack Hotchkiss	W7CNL	ID	271	20	< 5W		94	15	7	9870
Jim Cluett	W1PID	NH	10315	ALL	< 5W	23	100	14	7	9800
Randy Jones	K8ZFJ	RI	4653	20	< 1W	16	74	13	10	9620
Corey Minyard	AE5KM	TX	13611	20/40	< 5W	21	91	15	7	9555
Dave Brown	K8AX	OH	8151	20/40	< 5W	19	86	15	7	9030
Marcia Stockton	K6MEE	CA		20/40	< 5W		84	13	7	7644
Bill Crosier	NT9K	FL	13908	20	< 50mW	10	44	8	20	7040
Calvin Benoit	VA3BLP	ON		40	< 1W		54	11	10	5940
Brian Campbel	VE3MGY	ON		20/40	< 1W	14	67	8	10	5360
John Ketzler	W9FTC	WI	6403	20	< 5W	15	72	10	7	5040
Wayne Barnette	WA4AN	TN	13272	ALL	< 5W	13	62	10	7	4340
Harold Slack	VE5BCS	SK	13032	ALL	< 5W	15	60	9	7	3780
John Leediker	W5EEX	AZ	13443	20	< 5W	13	65	8	7	3640
Elwood C. Downey	WBØOEW	AZ	13322	40	< 5W		57	9	7	3591
Phillip J Bowers	KBØETU	AL	13659	20/40	< 5W	12	48	10	7	3360
Edwin "Ted" Albert	AB8FJ	OH	8544	20/40	< 5W	13	65	7	7	3185
Clarence A. Gardner	KH6G	HI	12911	20/40	< 5W	11	49	9	7	3087
Francis K. Dill Jr	WA3GYW	MD	5393	ALL	< 5W	11	49	9	7	3087
Howard Kraus	K2UD	NY	5889	20	< 5W	12	54	7	7	2646
Pete Spotts	W1PNS	MA	4174	20	< 5W	10	35	7	7	1715
Bill Cunningham	K4KSR	VA	12712	ALL	< 5W	7	32	7	7	1568
José A. Gurutzarri	EA2IF/P	*EA*		15/20	< 5W	8	28	7	7	1372
Bert H. Cook	K6CSL	CA	13513	20/40	< 5W	6	27	5	7	945
Jean-Pierre Couture	VA2SG/M	QC	13292	20	< 5W	5	25	5	7	875
Jim Gelbort	K9JG	FL	10453	20/40	< 5W	5	22	5	7	770
Brian Waddell	GM4XQJ	*GM*	7644	20	< 5W	4	20	4	7	560
David Scranton	W9WE	IL	12790	20/40	> 5W	11	52	8	1	416
George Tibbetts	KF4UCC	KY	13571	20	< 5W	3	15	3	7	315
John Watkins	NØEVH	MO	11484	20	< 5W	3	15	3	7	315
Ron Thompson	VE8RT	NT	7712	40	< 5W	2	7	2	7	98

rest of Sunday I used my FT-897D at 5 W from inside the house. —AA5TB

Condx seemed poor from this end. - KF7MD Conditions seemed quite good and I wished I had more time. —WØUFO

Tons of QRN. —N6DIT

GREAT CONTEST! One of my favorites. Could only operate Saturday but did manage to squeeze in one contact with Ron, WB3AAL Sunday morning. 20m was difficult with QSB and QRM but had some nice contacts in spite of it. 40m was good, and so was 80m. Called CQ on 160m with only one reply but the W4 station could not respond. —W1FMR

This was my very first QRP QSO Party effort. It was rather casual, in between yard work, church and family time. The bands were not in the greatest shape at my deep south Texas QTH, so I'm sure there were many more stations than what I heard. It was a lot of fun anyway. I'm looking forward to the next one —K5JX

Was entertaining grandchildren over Easter weekend, so didn't get a lot of time on the radio, but was glad to hear some more activity than I could hear in last few of these events. —VA7DER

Had fun with the IC-703. It is a FB rig. Didn't get to operate much but got 2 DX. CU next contest. —K9FO

My first QRP-ARCI Contest Submission. —KE4RQ

Entire contest worked outside in backyard under battery power with two dogs at my side. The weather was beautiful and it was too nice to be in the shack. —W3HZZ

Because of work commitments I just dabbled, search and pounce only, but had fun. 20m poor during morning and only heard VA3RKM, who lives a couple of km away, on 15m and 10m. Had fun with the FT-80 at 3W on Saturday evening but Sunday night was much too noisy at this QTH (S9+) for 80m. —VE3EUR

Managed some QRP fun, just parked on 20m while woodworking and yard work. —K8ZFJ

Fun contest, I didn't get to work very much, but made quite a few contacts for the little work I did. Looks like the band conditions are improving. —AE5KM

My first QRP contest. My goodness the band was strange this weekend. On-and-off sudden QSB. I heard folks on SSB talking about strange condx also. It was a good learning experience dealing with QRP signals. —K6MEE

My first QRP ARCI event. I had fun, but didn't get enough time as I had hoped for. I look forward to the next event. —NT9K

The band does not open up for us except mid day. I enjoyed using straight key; I am not a big contester. —VE5BCS

My second QRP-ARCI contest; not spectacular results, but better than Pet Rock, which was only 2 QSOs. I had a good time. Operated Saturday afternoon from top of S. Mountain here in Phoenix, then on Sunday from the home QTH. —W5EEX

Had lots to do Saturday so didn't get a lot of time in. Sunday, being Easter, the bands seemed to have died, at least up to the last hour. This was my first QRP ARCI Party/Sprint, but won't be my last. Sure wish the "fast" guys would slow down a bit—they might get a few more conteacts. At least us "slow" guys would appreciate it. —KBØETU

Propagation was poor, but I worked into EA Spain on 15m! —WA3GYW

Had to re-align my rig. Started working stations after I got the transmit offset right! —K2UD

Used 8 watts for the contest ... No QRP Equipment. —W9WE ●●

Contest Announcements

FOR ALL CONTESTS:

Email Log Submission:

Submit Logs in plain text format along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation to va3jff@yahoo.ca

Snail mail Log Submission:

Submit Logs along with a summary stating your Callsign, Entry Categorym Actual Power and Station Description along with score calculation to:

(Contest Name)
c/o Jeff Hetherington, VA3JFF
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

Results will be published in *QRP Quarterly* and shown on the QRP-ARCI website. Certificates will be awarded to the top scoring entrant in each category, as well as the top scoring entrants from each State, Province and Country. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2010 QRP-ARCI Fall QSO Party

Date/Time:

1200Z on 16 October 2010 through 2400Z on 17 October 2010. You may work a maximum of 24 hours of the 36 hour period.

Mode:

HF CW only.

Exchange:

Members send: RST, State/Province/Country, ARCI member number

Non-Members send: RST, State/Province/Country, Power Out

QSO Points:

Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:

>5 Watts = ×1
>1 - 5 Watts = ×7
>250 mW - 1 Watt = ×10
>55 mW - 250 mW = ×15
55 mW or less = ×20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (also 7040 kHz for rock bound hams)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:

Final Score = Points (total for all bands) × SPCs (total for all bands) × Power Multiplier.

Multioperator:

New for 2010! A multioperator effort may submit logs for a separate category. Any combination of operators and transmitters will be permitted. All transmitters must be located at a centralized location. All operators must use the same callsign in the multioperator category.

Teams:

You may enter as a team with an unlimited number of operators as long as no more than 5 transmitters are on the air concurrently. You compete individually as well as on the team. Teams need not be in the same location. Team captains must send a list of members to the Contest Manager before the contest.

Entry Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang

out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Entry Deadline:
Entries must be postmarked on or before 18 November 2010.

2010 QRP-ARCI Top Band Sprint

Date/Time:
0000Z to 0600Z on 2 December 2010
(Note, this is the evening of 1 December 2010 in North America)

Mode:
SSB, CW or Mixed Mode. Work stations once regardless of mode.

Exchange:
Members send: RS(T), State/Province/Country, ARCI member number
Non-Members send: RS(T), State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total

Power Multiplier:
Use the smaller multiplier if different for each mode.

For SSB QSOs:
>10 Watts = ×1
>2 - 10 Watts = ×7
>500mW - 2 Watts = ×10
>100mW - 500mW = ×15
100mW or less = ×20

For CW QSOs:
>5 Watts = ×1
>1 - 5 Watts = ×7
>250 mW - 1 Watt = ×10
>55 mW - 250 mW = ×15
55mW or less = ×20

Suggested Frequencies:
CW: around 1810 kHz
SSB: around 1910 kHz
*Please remember that 1830 to 1835 kHz should be used for intercontinental QSOs only

Bonus Points:
None available for this contest.

Score:
Final Score = Points (total for all bands) × SPCs (total for both modes) × Power Multiplier

Entry Categories:
Entry may be SSB, CW or Mixed Mode

How to Participate:
Get on Top Band and hang out near the QRP frequencies listed above. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once regardless of mode.

Entry Deadline:
Entries must be postmarked on or before 2 January 2011.

2010 QRP-ARCI Holiday Spirirts Homebrew Sprint

Date/Time:
2000Z to 2359Z on 19 December 2010

Mode:
HF CW Only.

Exchange:
Members send: RST, State/Province/Country, ARCI member number
Non-Members send: RST, State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:
>5 Watts = ×1
>1 - 5 Watts = ×7
>250 mW - 1 Watt = ×10
>55 mW - 250 mW = ×15
55 mW or less = ×20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (also 7040 kHz for rock bound hams)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:
Final Score = Points (total for all bands) × SPCs (total for all bands) × Power Multiplier + Bonus Points.

Bonus Points:
If operating a HB Transmitter add 2000 points per band
If operating a HB Receiver add 3000 points per band
If operating a HB Transceiver add 5000 points per band
(Homebrew is defined as: if you built it, it is homebrew—kits too!)
If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:
Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

How to Participate:
Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Entry Deadline:
Entries must be postmarked on or before 19 January 2011.

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By Hams For Hams

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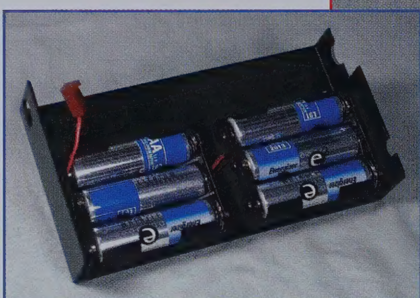

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